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SCIENCE APPLICATIONS INC EL SEGUNDO CALIF
TITANIUM RESPONSE TO SIMULATED NUCLEAR CLOUD PARTICLE ENVIRONME--ETC(U)
AUG 77 L E DUNBAR, R M CLEVER, G H BURGHART DNA001-76-C-0366

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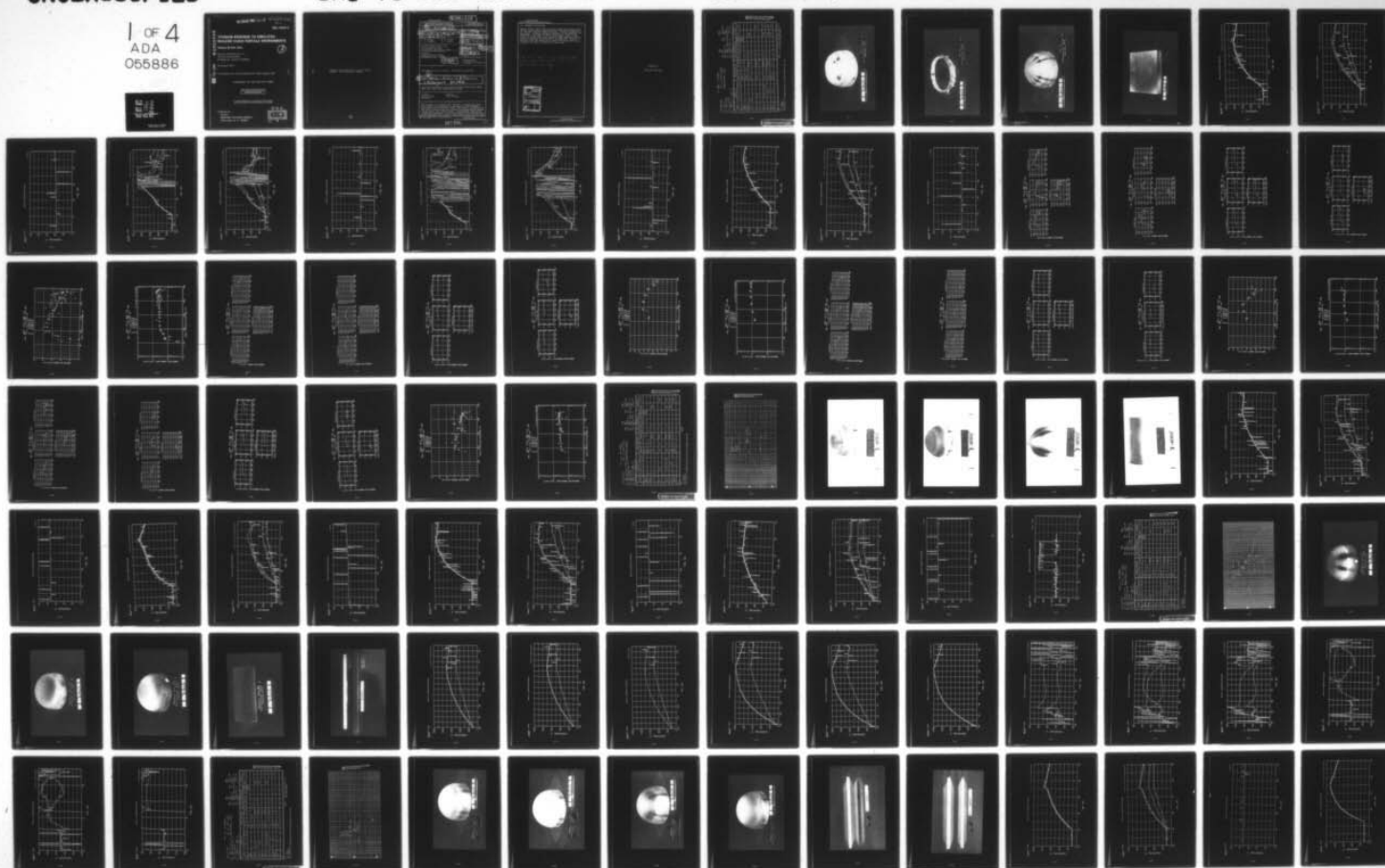
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SAI-78-561-LA-VOL-2

DNA-4404F-2

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1 OF 4
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DNA 4404F-2

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TITANIUM RESPONSE TO SIMULATED NUCLEAR CLOUD PARTICLE ENVIRONMENTS

Volume II-Test Data

Science Applications, Inc.
101 Continental Blvd.
El Segundo, California 90245

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B.S.

31 August 1977

Final Report for Period September 1976—August 1977

CONTRACT No. DNA 001-76-C-0366

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6. TITLE (and Subtitle) TITANIUM RESPONSE TO SIMULATED NUCLEAR CLOUD PARTICLE ENVIRONMENTS Volume II - Test Data.		9. TYPE OF REPORT AND PERIOD COVERED Final Report, Period Sep 76 - Aug 77	
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18. SUPPLEMENTARY NOTES This work sponsored by the Defense Nuclear Agency under RDT&E RMSS Code B342077464 N99QAXAA12942 H2590D.		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE	
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) Titanium Erosion Nuclear Cloud Heat Transfer Oxidation			
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) The response of titanium alloy (6Al-4V) to simulated nuclear cloud particle environments is addressed in this combined experimental and analytical study. The results are applicable for ascent vehicles with hot titanium structures flying through nuclear burst ice or dust clouds. A three-phase exploratory program was conducted: An initial oxidation test series using an SAI-designed test fixture, a test series using the AEDC Dust			

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20. ABSTRACT (Continued)

Erosion Tunnel (DET), and a particle impact test series using the SAI hypervelocity impact facility. Analytical modeling of titanium oxidation produced results in close agreement with experiment. Although increased oxidation of titanium was confirmed in H₂O vapor versus O₂ environment tests, no net effect of liquid H₂O and O₂ oxidation under combined particle erosion conditions was observed in the AEDC DET. This is believed to be the result of the heat of vaporization of H₂O exceeding the heat of oxidation of H₂O vapor.

→ See Volume I for complete abstract. This volume contain AEDC DET test data and SAI oxidation test data.

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APPENDIX A
AEDC DET TEST DATA

TABLE A-1 RUN SUMMARY

TUNNEL CONDITIONS
 $P_0 = 994$ psia
 $P_{0B} = 765$ 3tu/1bm
 $P_{0C} = 8tu/1bm$
 $T_{0B} = 2890$ °R, $T_0 =$ °R
 $M = 7.1$ $P_0' = 10$ psia

DUST
MgO
TYPE SIZE μ m C.F.
100 14.1
4600 0.016 in.
Flow 11.49 gm/sec ΔP 741 psi
C.F. 33.7

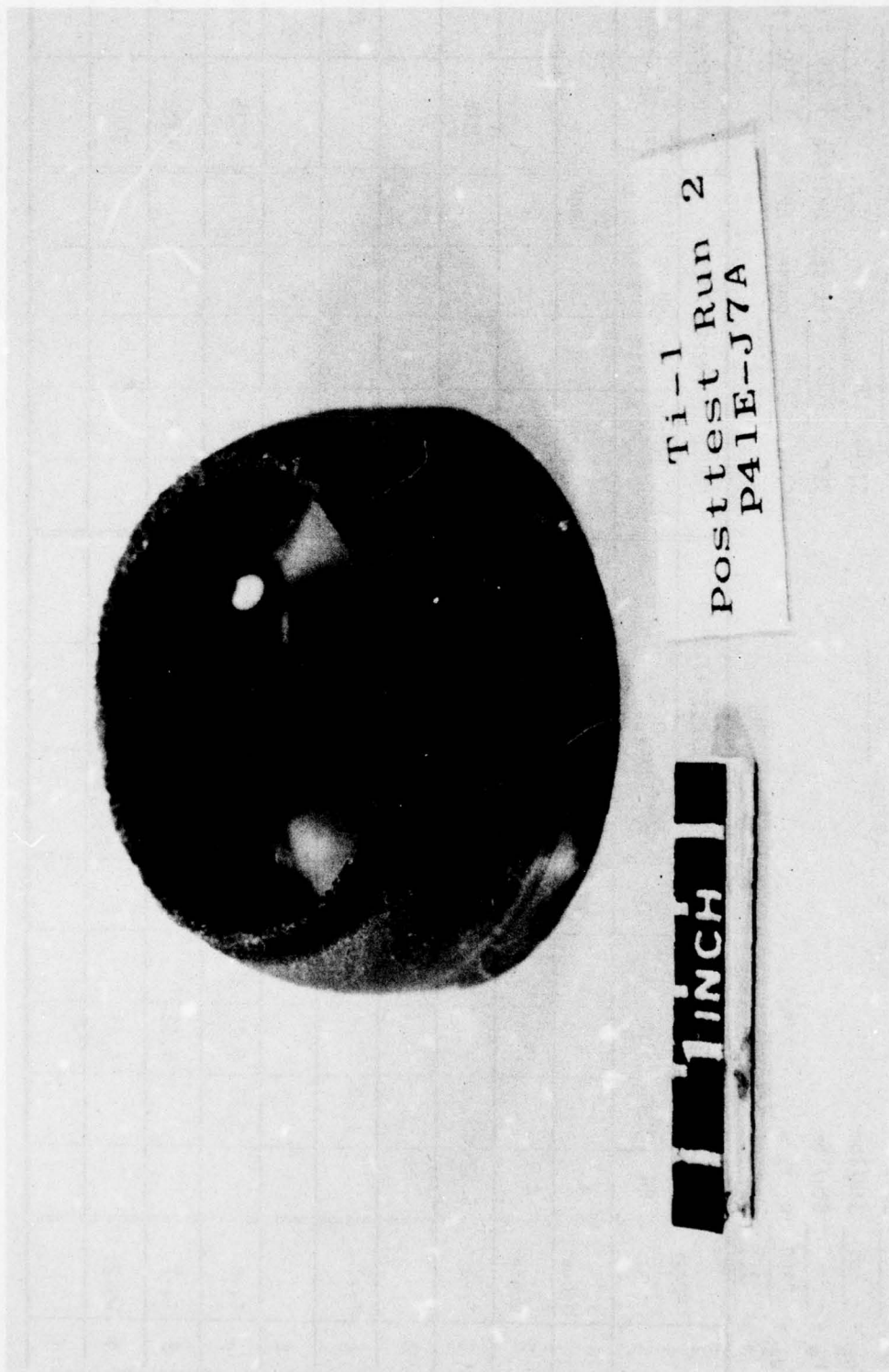
WATER
Flow 0.13 gpm
C.F. 14.1
Orifice 0.016 in.
741 psi

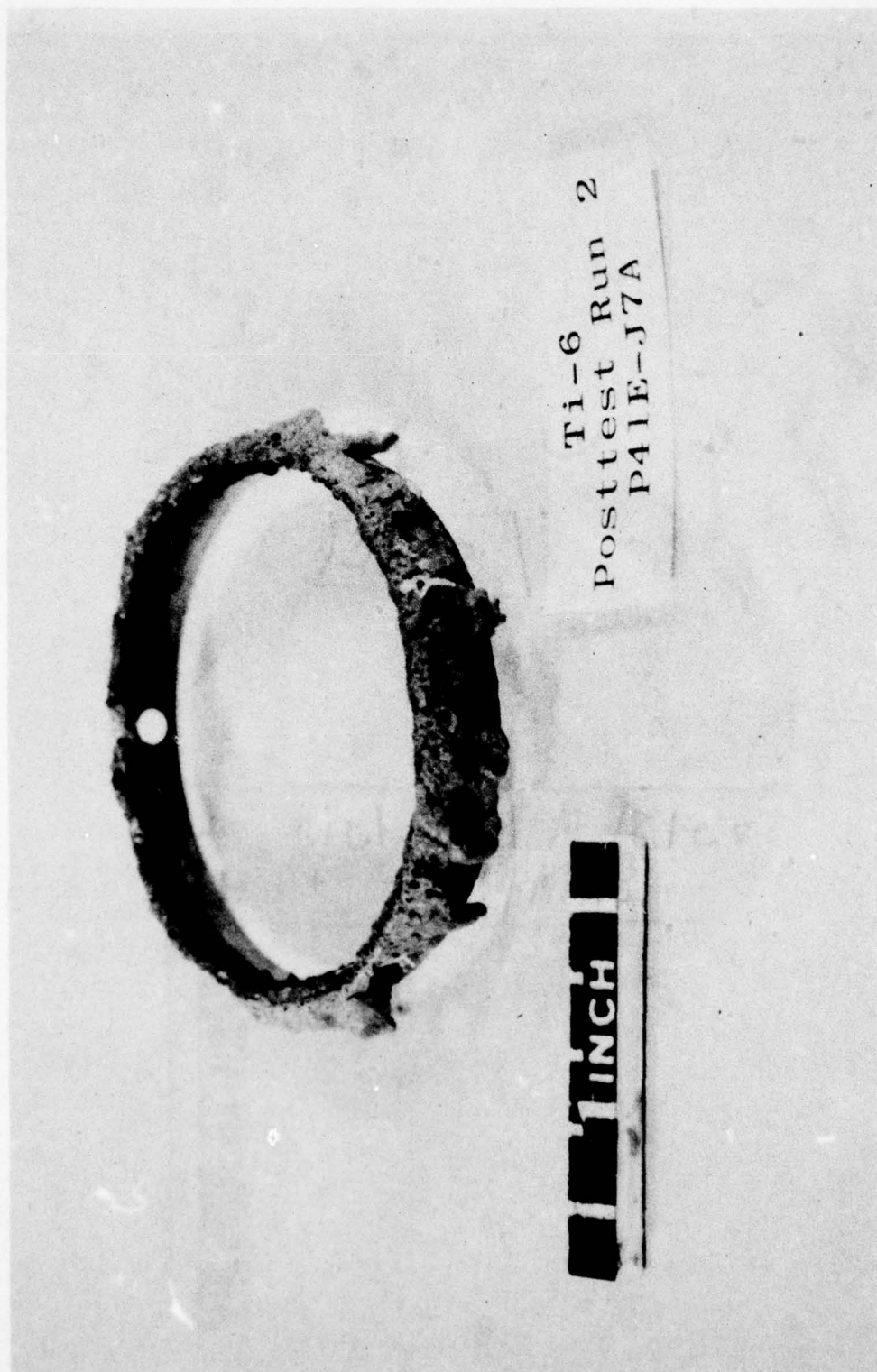
RUN 2 DATE 11-23-76
NOZZLE STATION 127.5

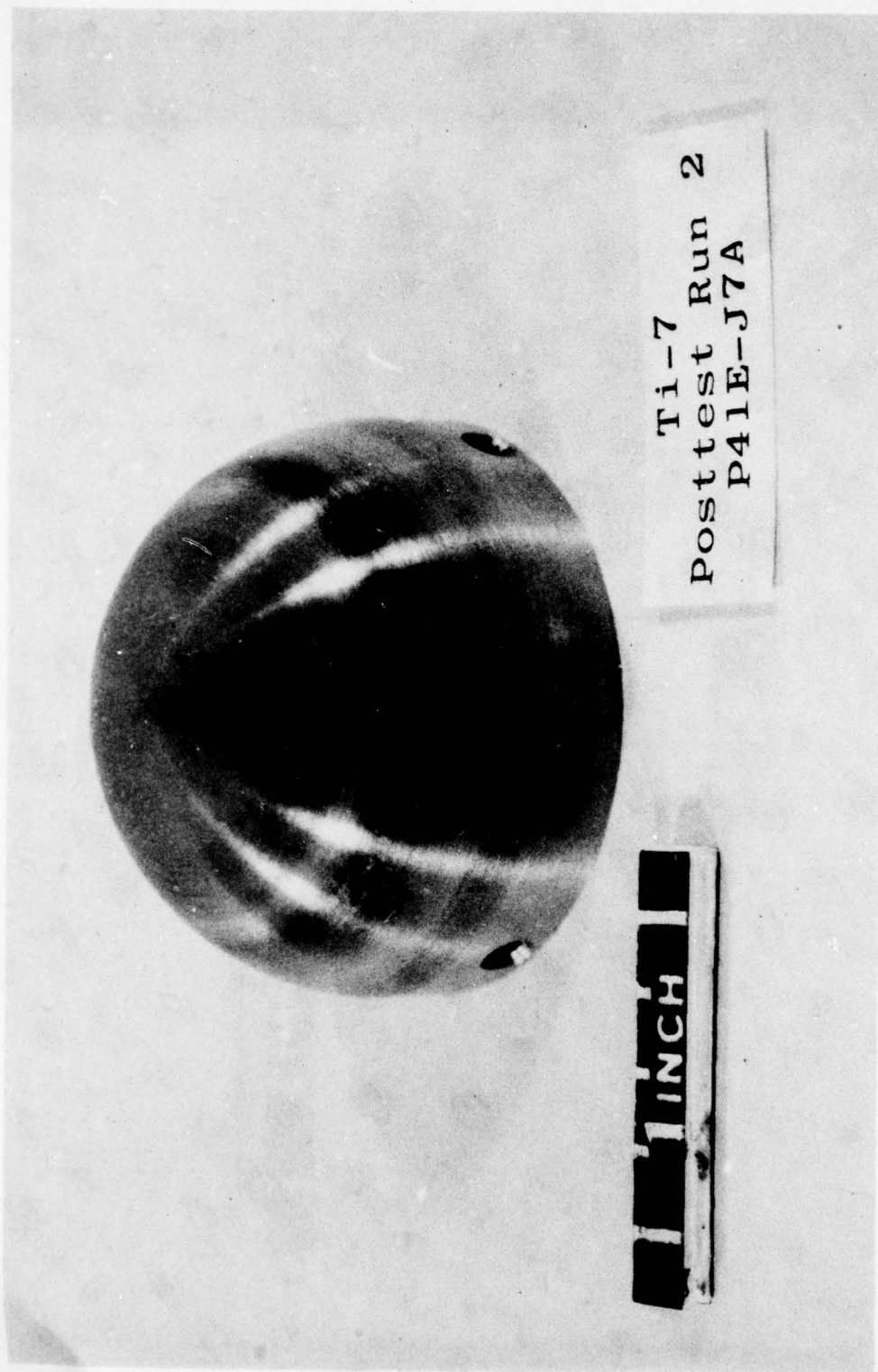
S E R I A L N O.	MODEL NUMBER	EXPOSURE TIME				MODEL DESCRIPTION			MODEL INSTRUMENTATION				PHOTOGRAPHS			
		PH	DUST	H ₂ O	DUST & H ₂ O	POH	GEOMETRY	DIAM, In.	MATERIAL	T/C TYPE	NO. OF T/C's	PR. TAP	NO. OF TAPS	TRANS- DUCER TYPE	PRERUN	POSTRUN
1	Po probe	3					See Fig. 3	1.0	SS			x	1	Strain Gage		
2	To probe	4					See Fig. 3	0.25		R	1					
3	Ti-5	5.52					Hemi	2.0	6A1-4V- Ti	S	8				6835	
4																
5	Ti-1		4.29				Hemi	2.0	6A1-4V- Ti	S	8					7925
6																
7	Ti-6		3.83	6.41	3.83		Hemi	2.0	6A1-4V- Ti	S	8				6835	7922
8	Ti-7			5.63			Hemi	2.0	6A1-4V- Ti	S	8				6835	7924
9	WB-2			5.67			See Fig. 2		Al						7009	7923
10																

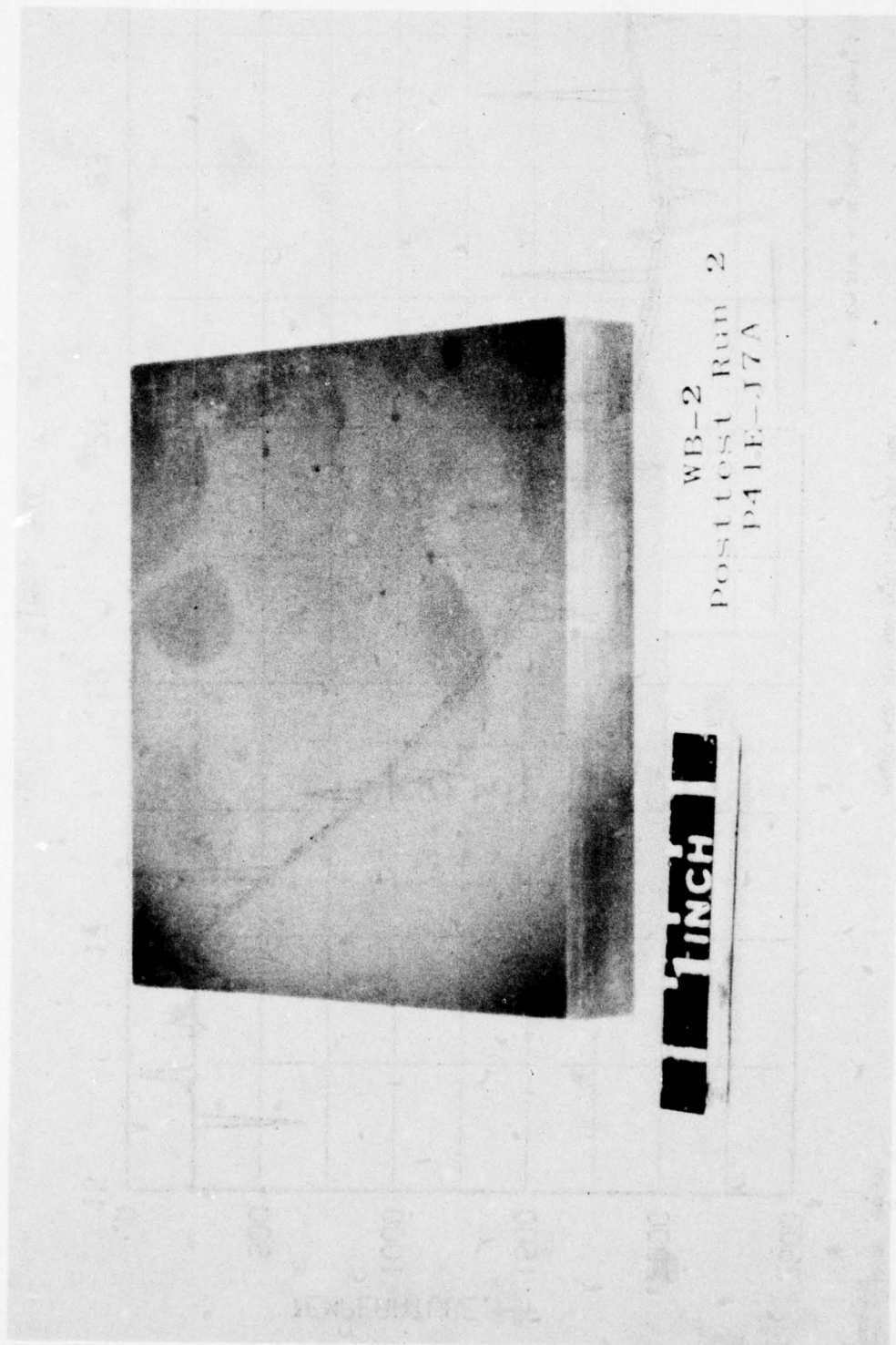
NOTES: 1. To probe did not reach equilibrium.
2. Ti-1 and Ti-6 burned through.

KEY -
PH - PREHEAT
POH - POSTHEAT
DUST AND H₂O - IF CHECKED, MEANS DUST AND WATER FLOWING AT SAME TIME





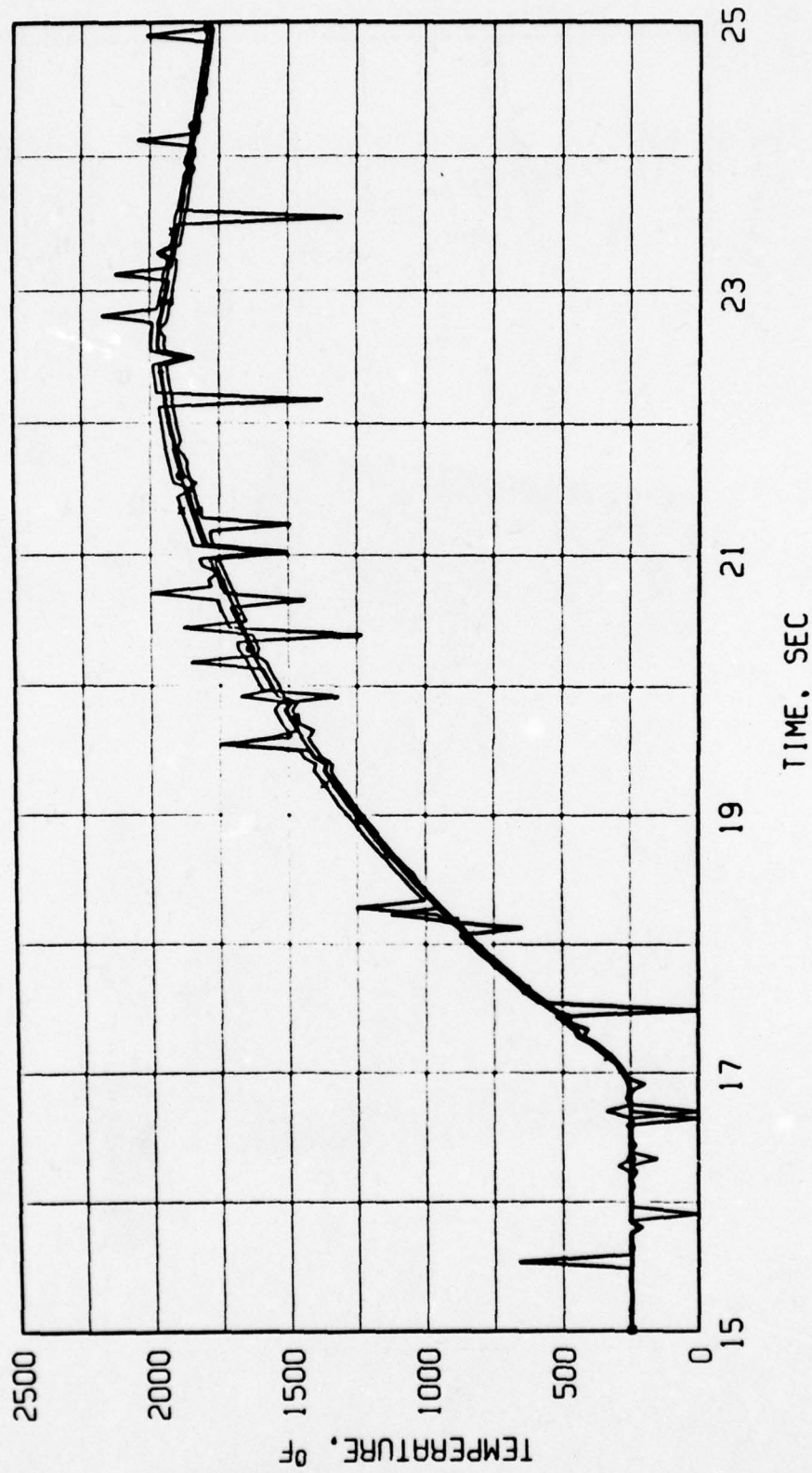




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PROJ-PNIE

PROJECT PNIE TEST 00021 DATE 11-23-76 SEL 2102

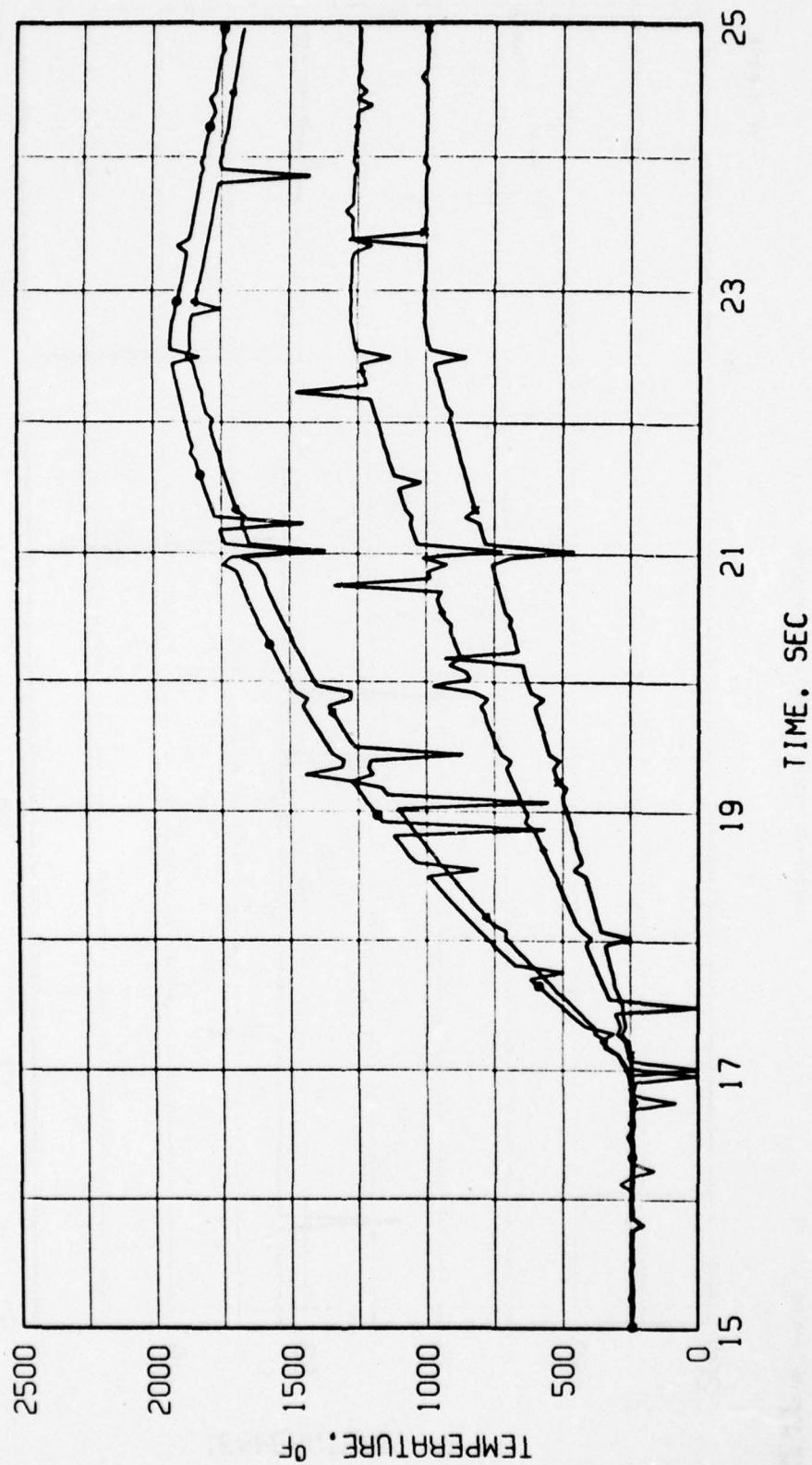
X TC-4-TI-S + TC-3-TI-S ▲ TC-2-TI-S ○ TC-1-TI-S



PROJECT PILE TEST R0021 DATE 11-23-76 SEL 2102

DATE 12-02-76 AND INC
PROJ-PILE

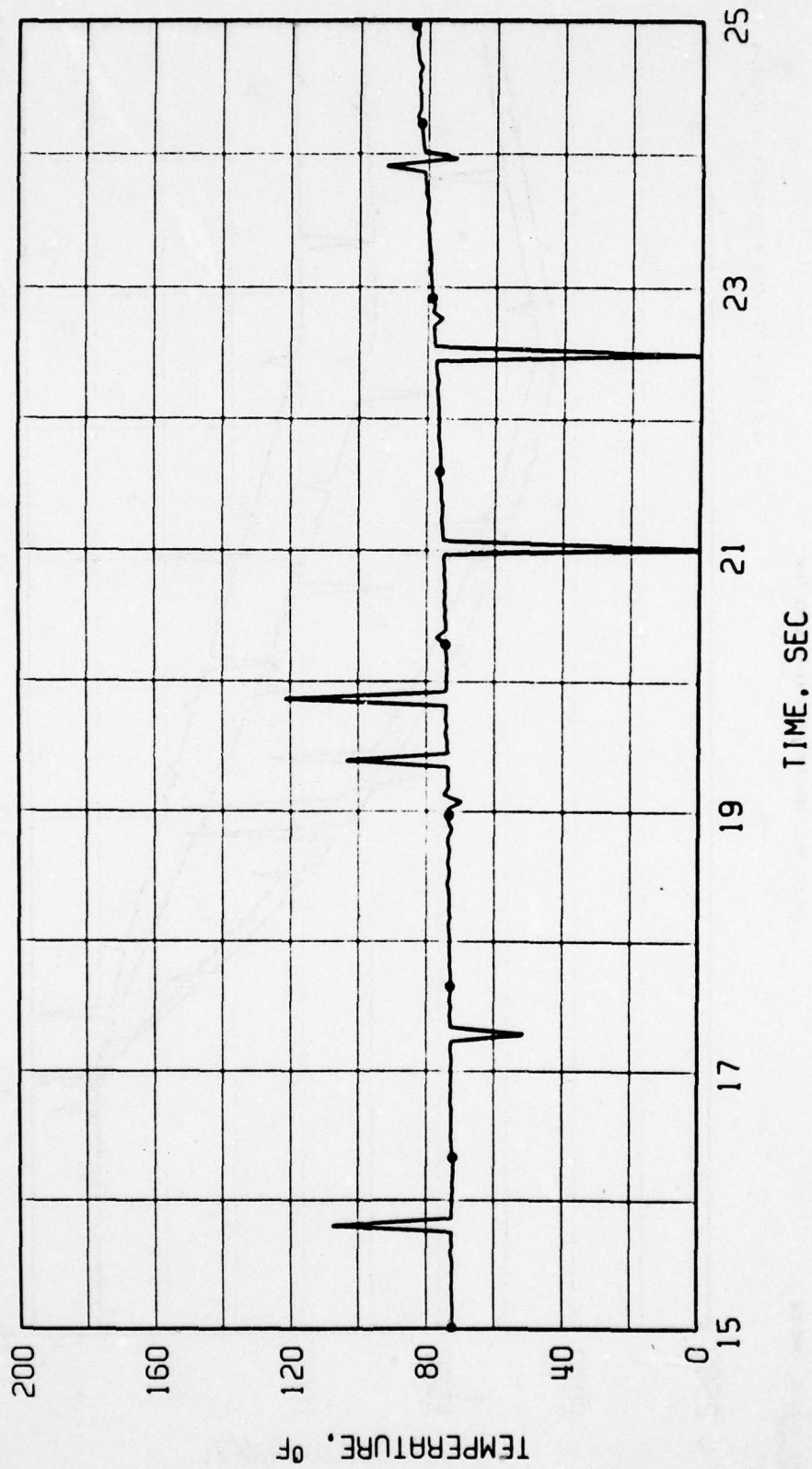
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DATE 12-02-76 RMD INC
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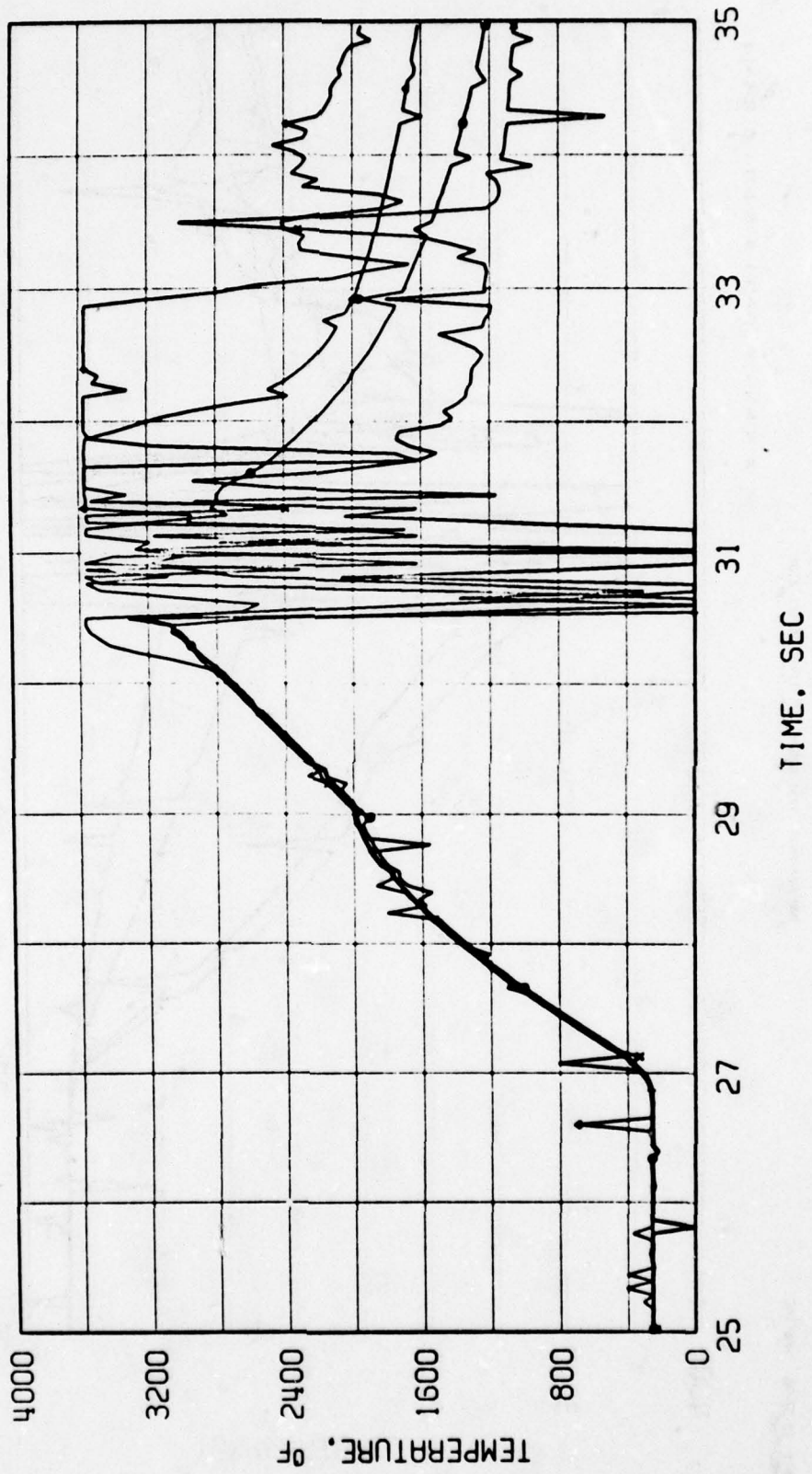
TC-9-TI-5



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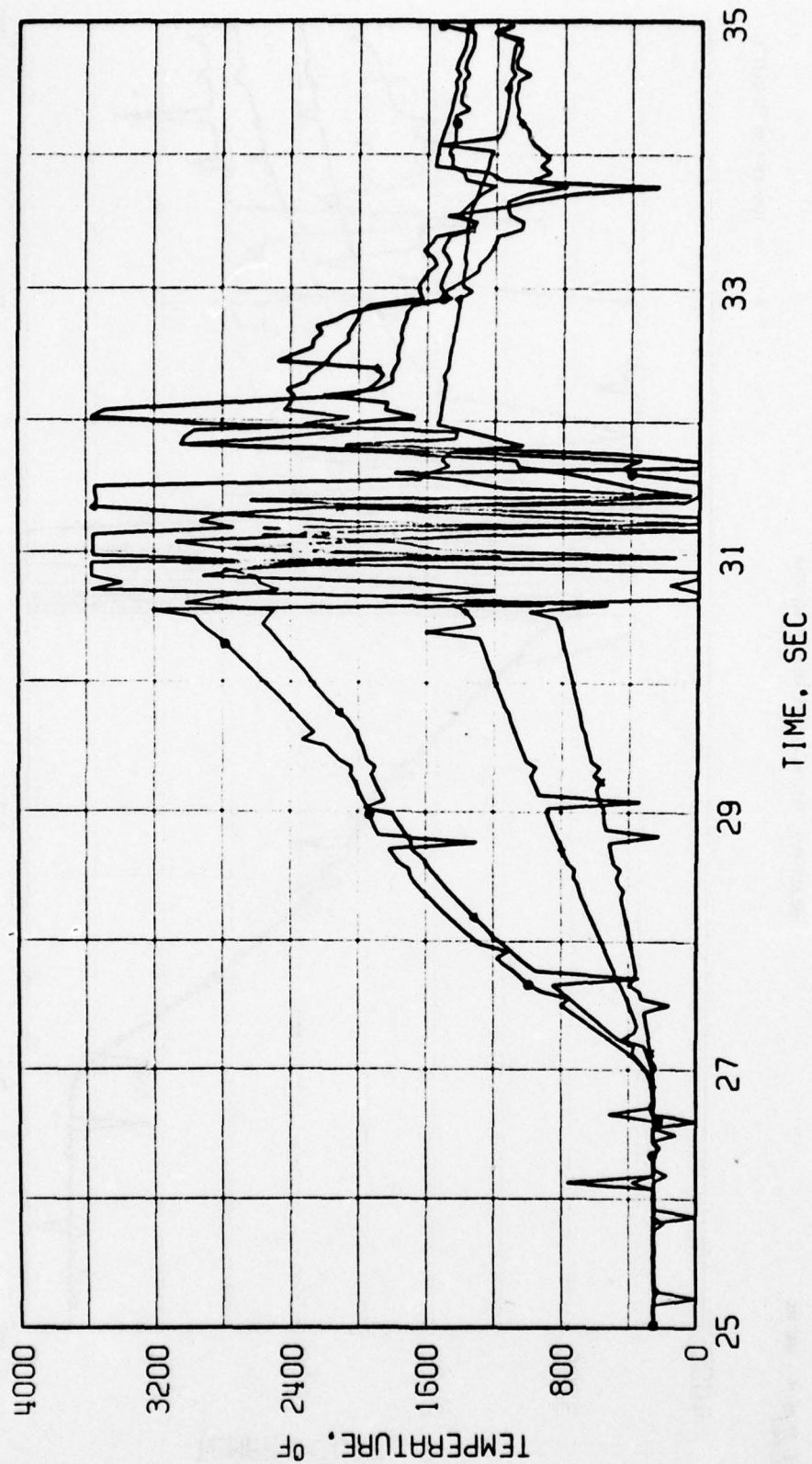
x TC-4-TI-1 + TC-3-TI-1 ▲ TC-2-TI-1 ○ TC-1-TI-1



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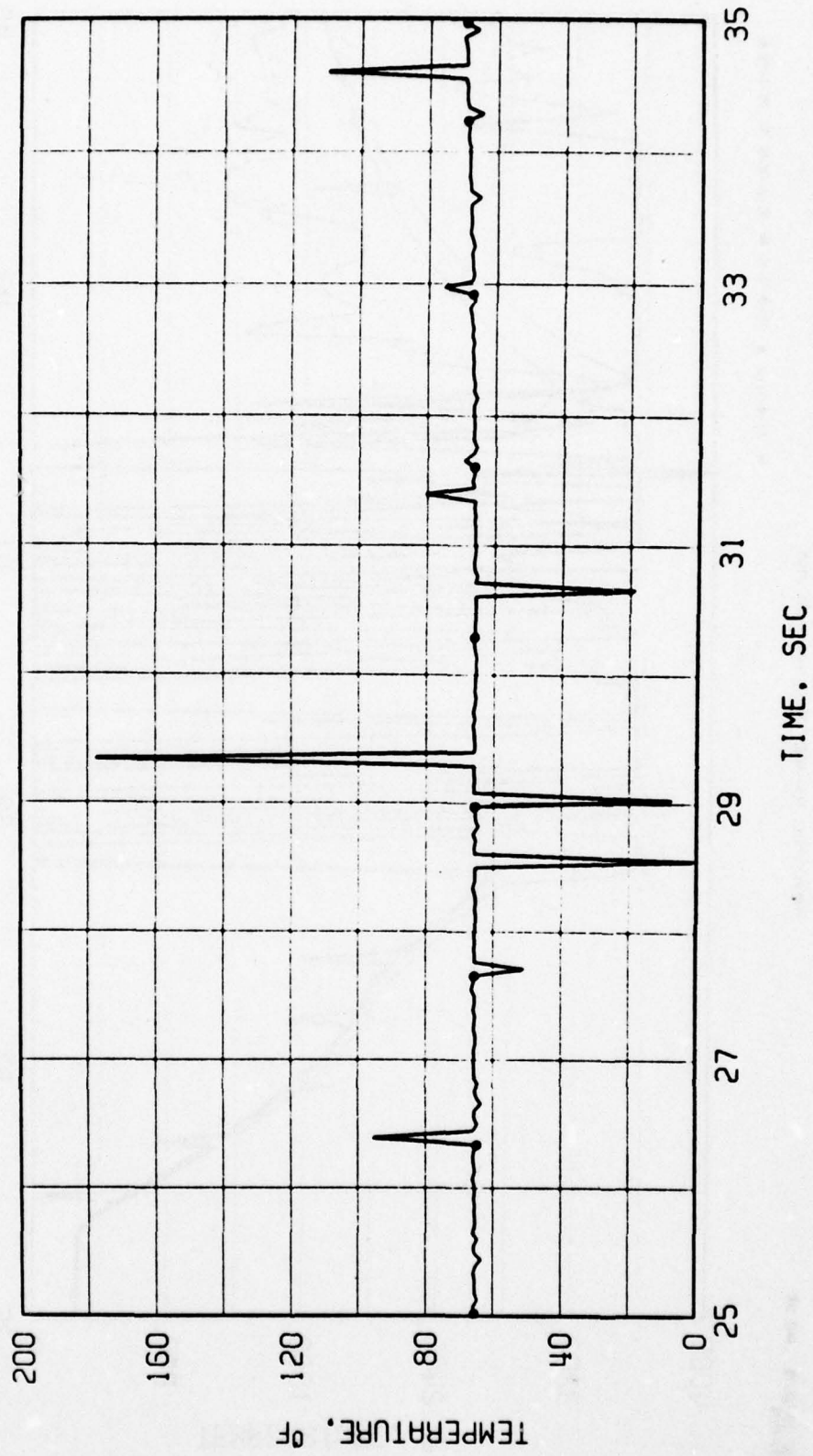
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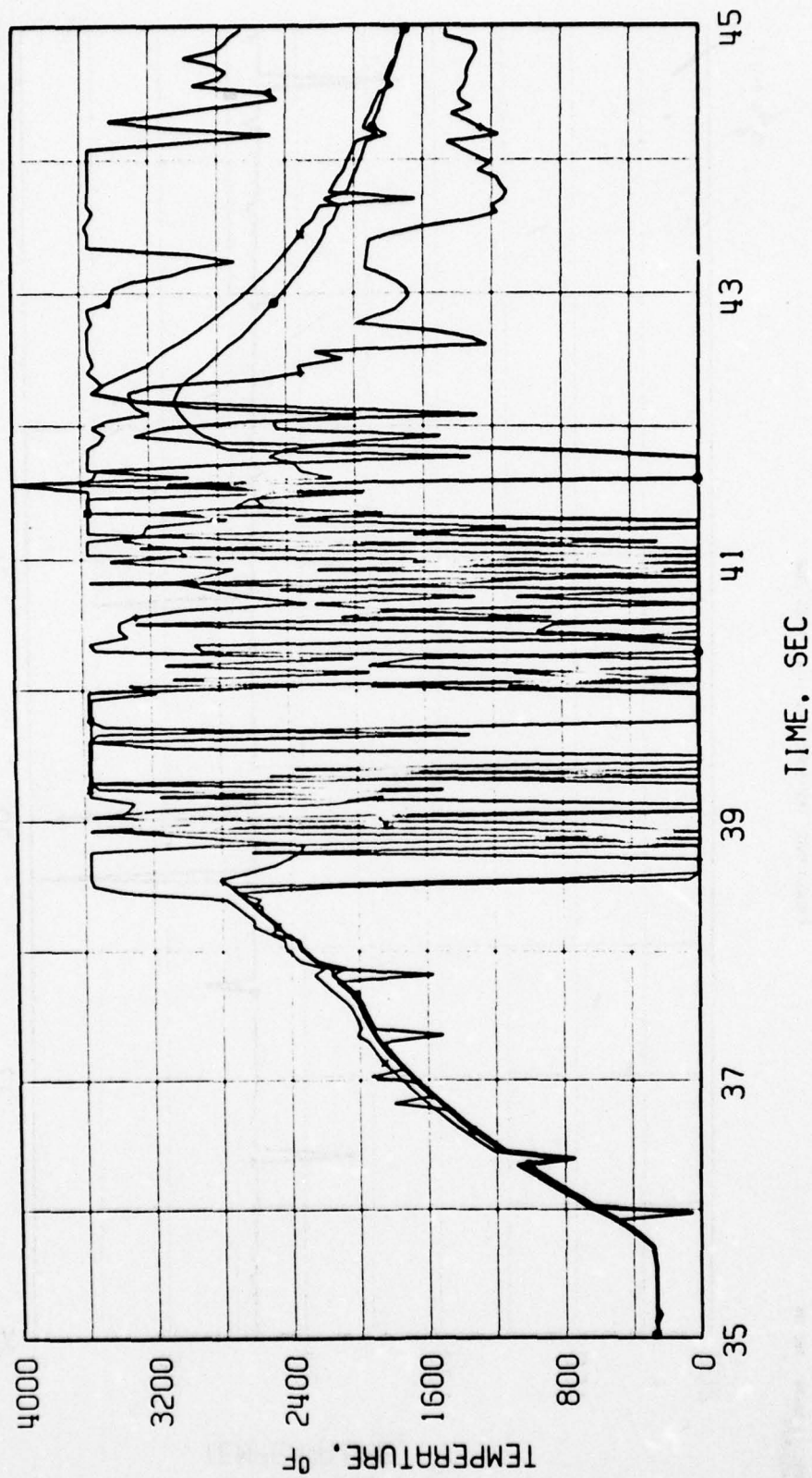
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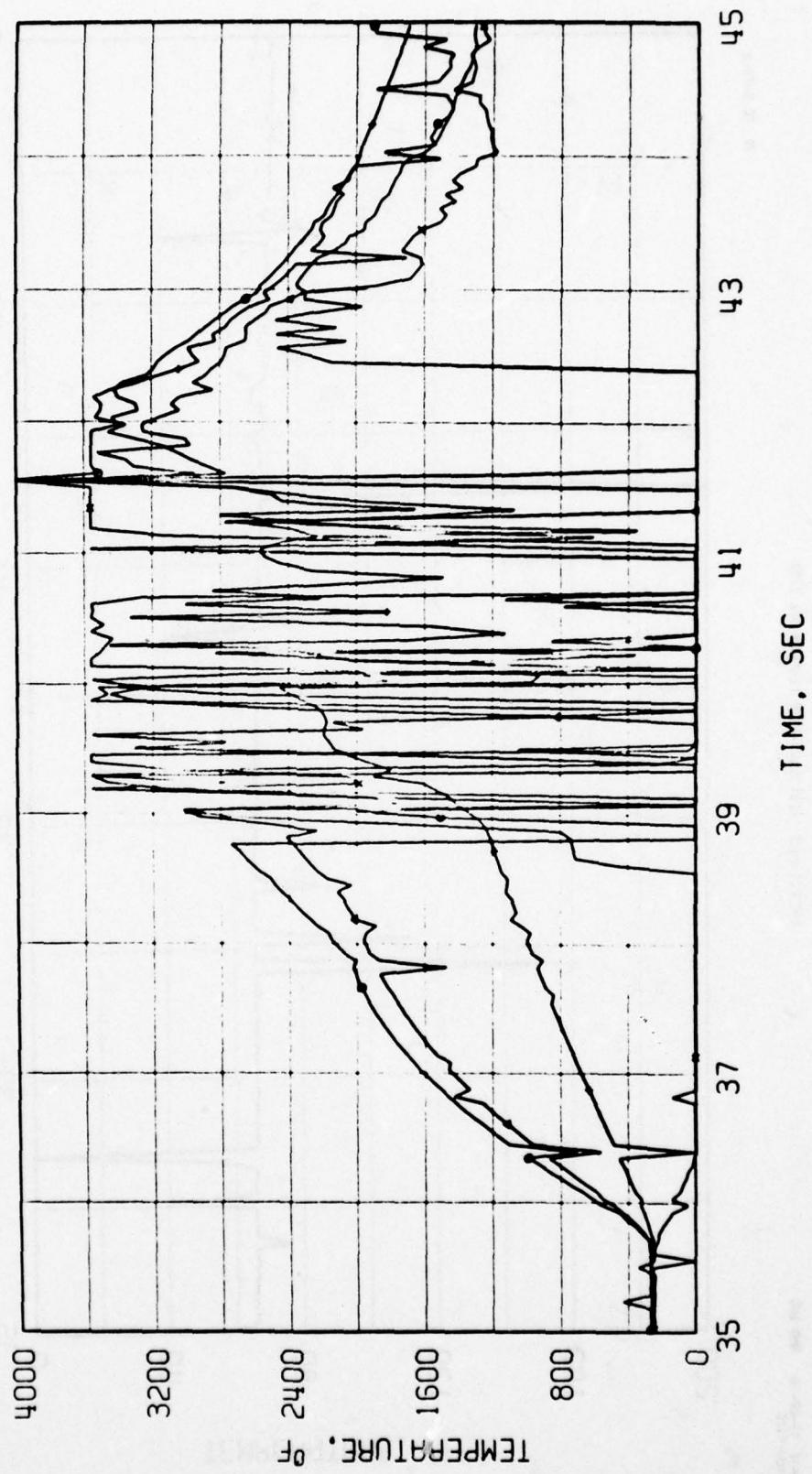
X TC-4-TI-6 + TC-3-TI-6 ▲ TC-2-TI-6 ○ TC-1-TI-6



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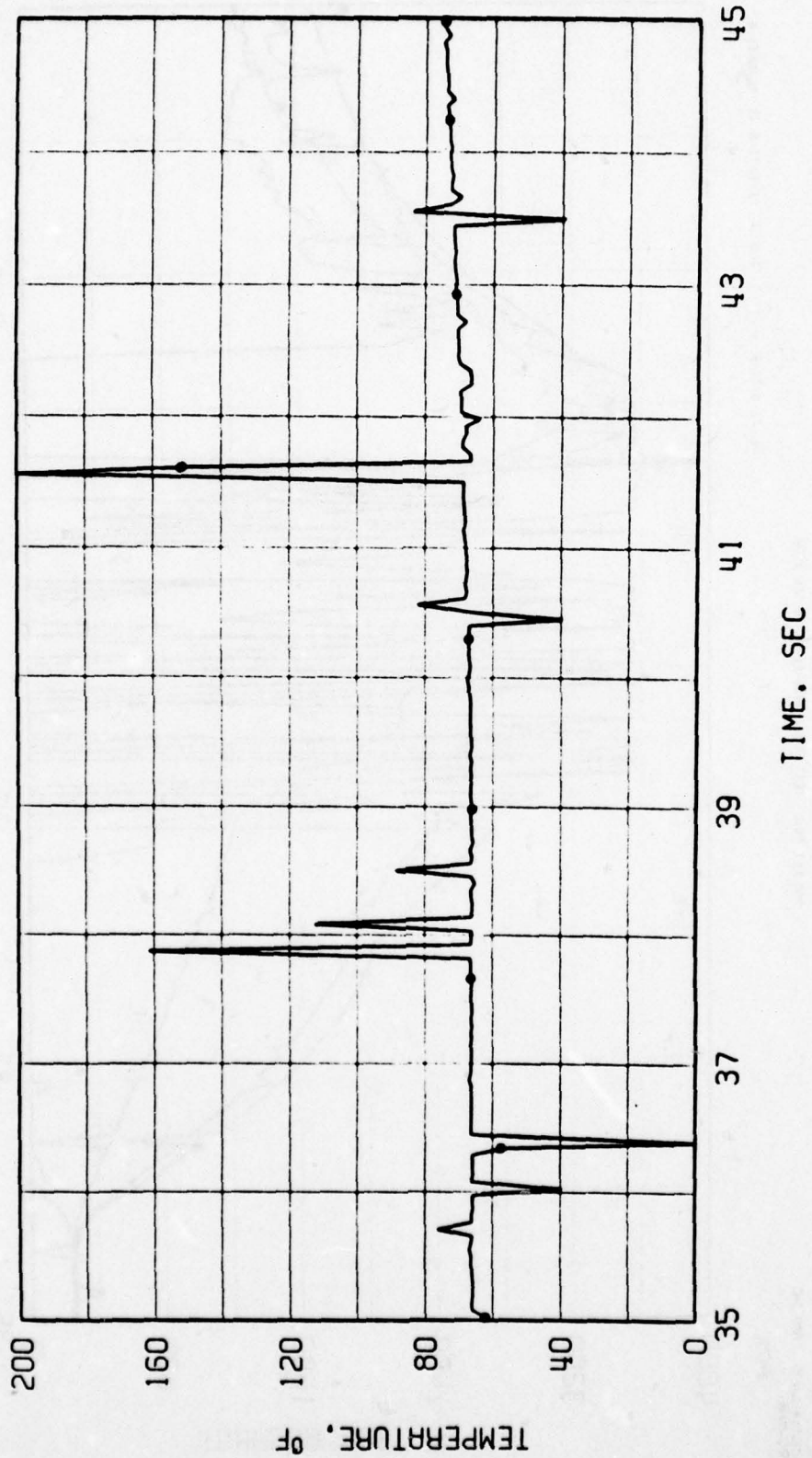
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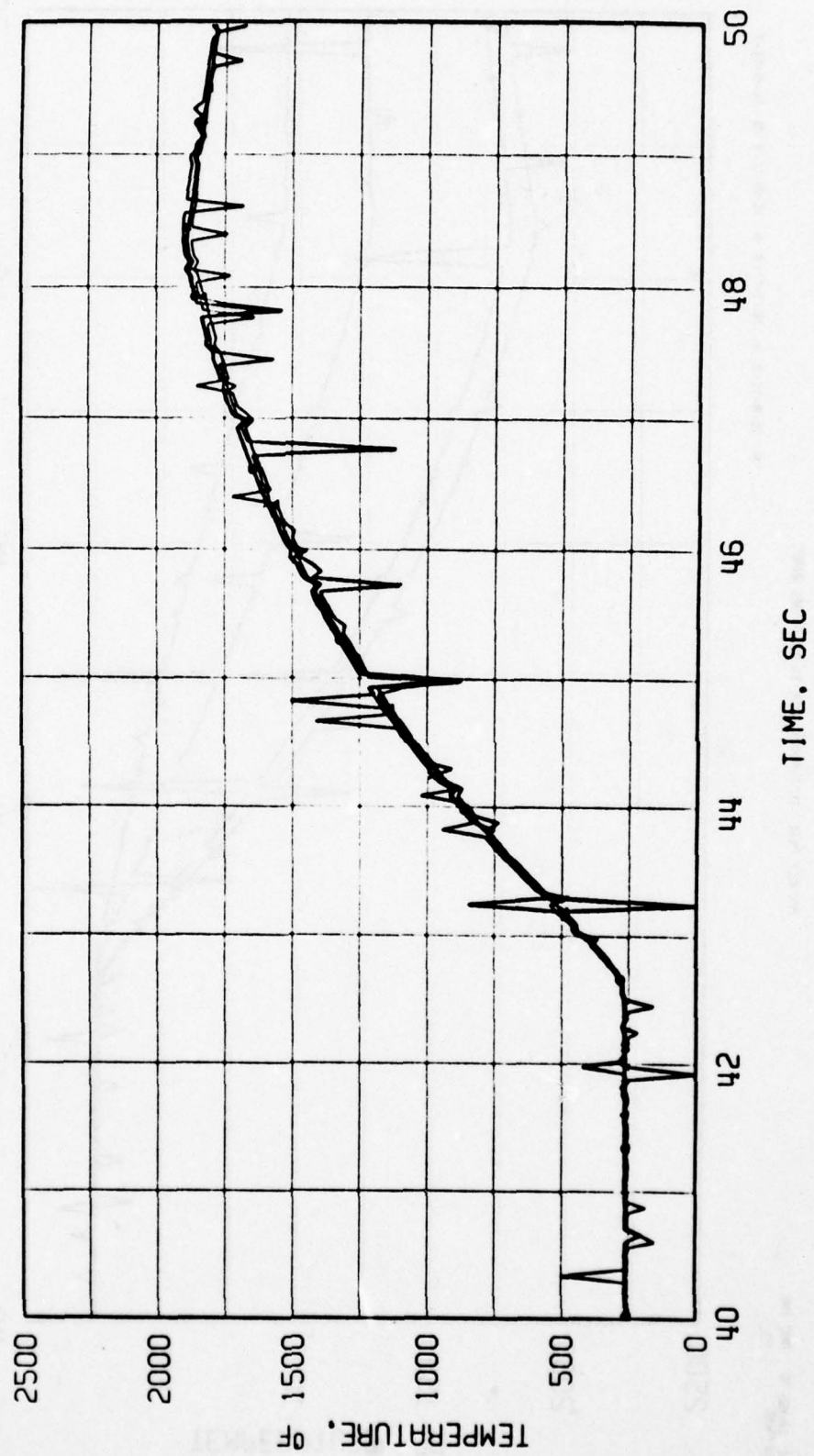
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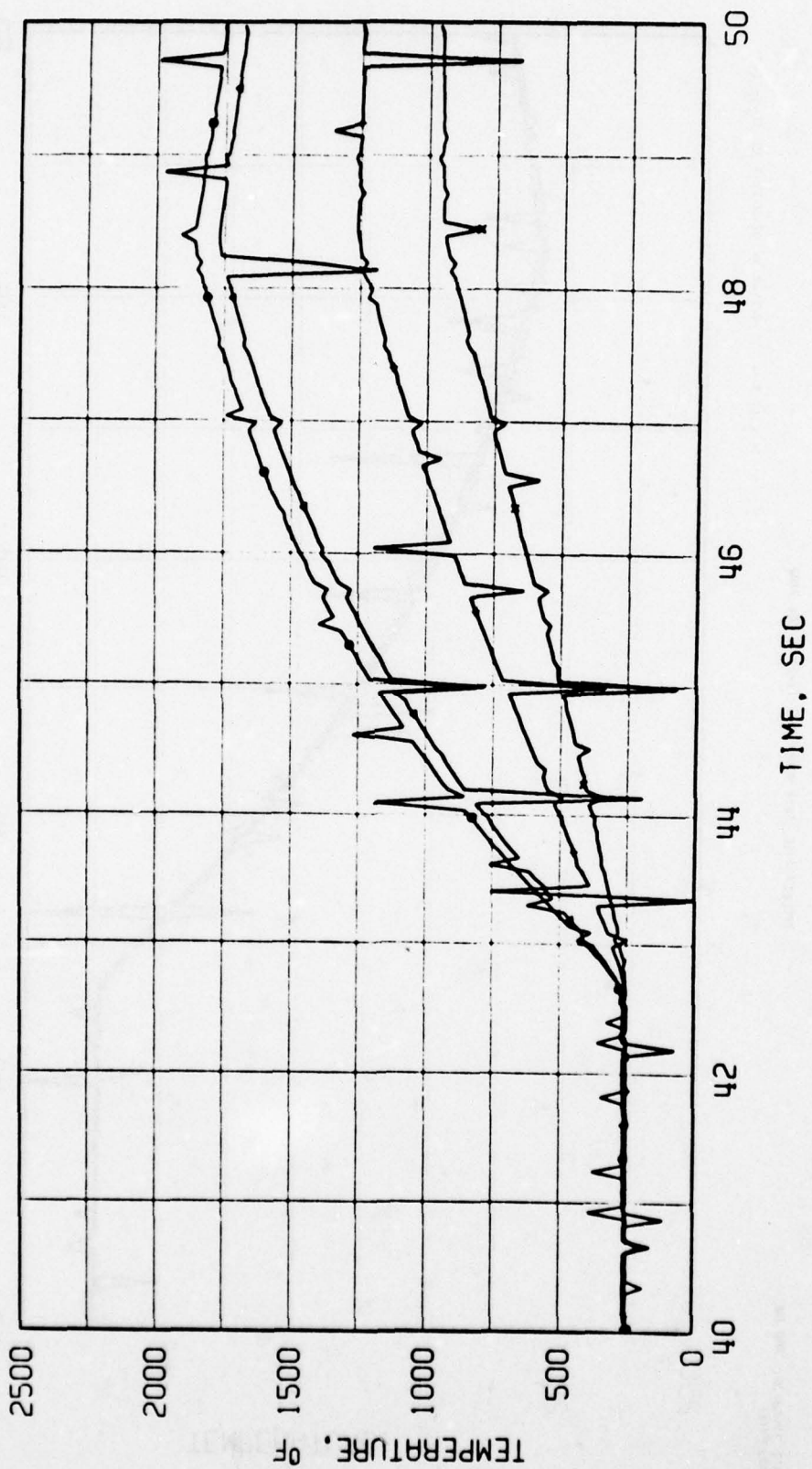
X TC-4-T1-7 + TC-3-T1-7 ▲ TC-2-T1-7 ○ TC-1-T1-7



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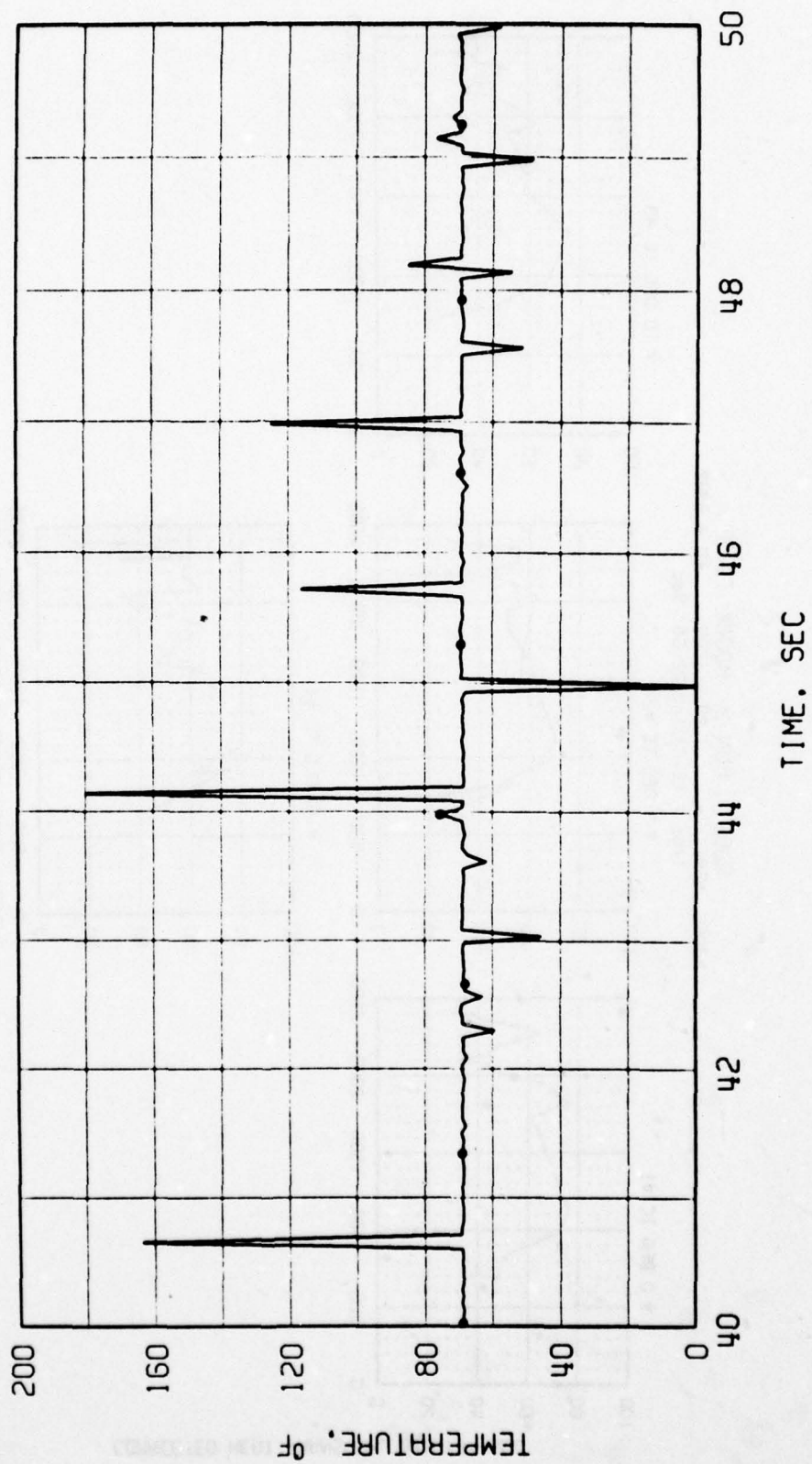
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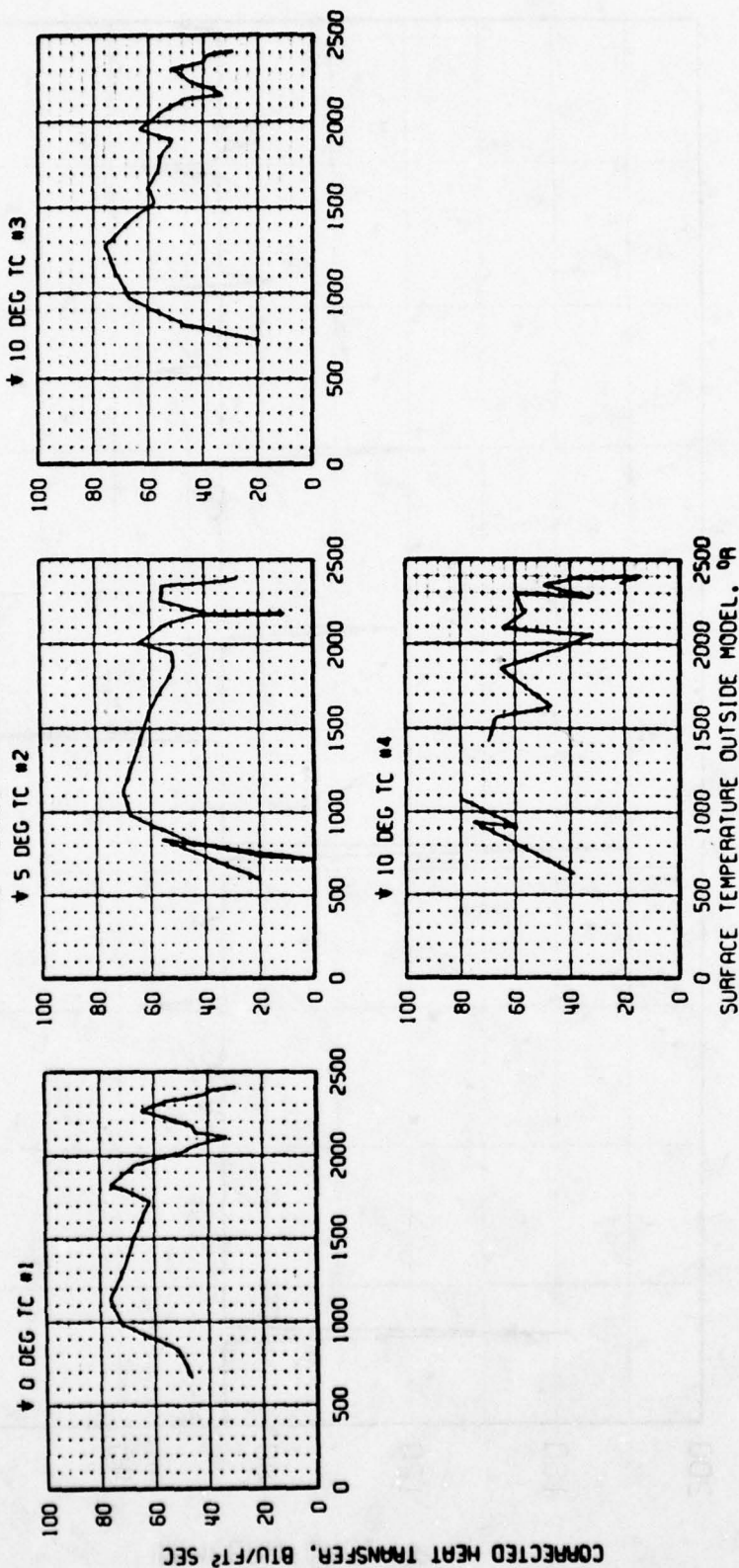
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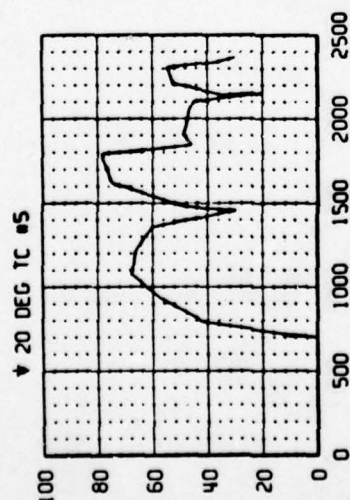
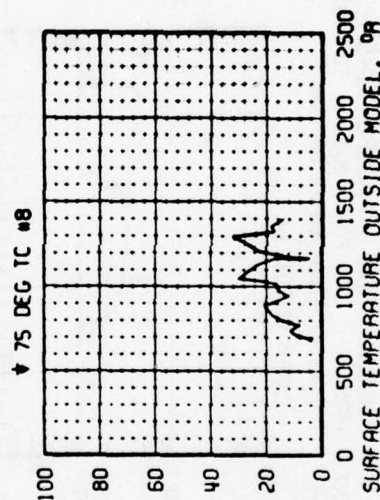
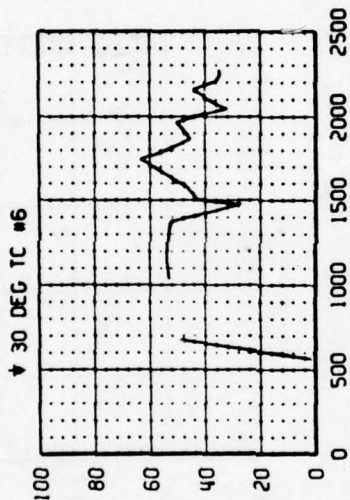
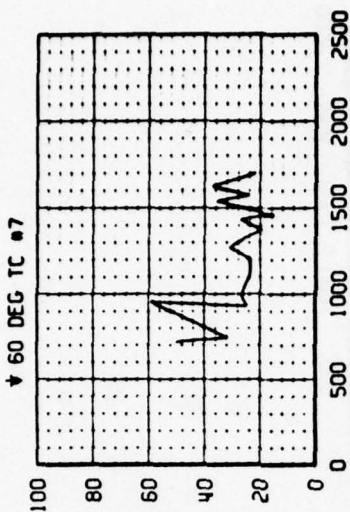


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 MODEL HEMI P0 = 1000 T0 = 3348
 Time = 16.06 to 22.60 Sec



SURFACE TEMPERATURE OUTSIDE MODEL, °R

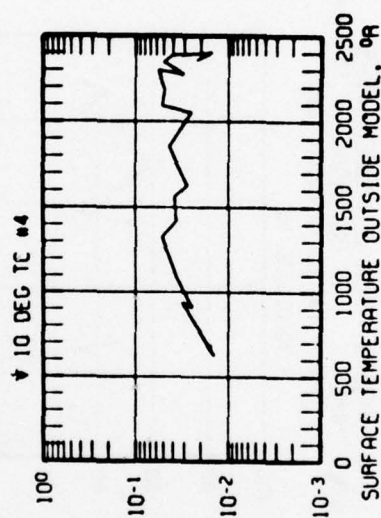
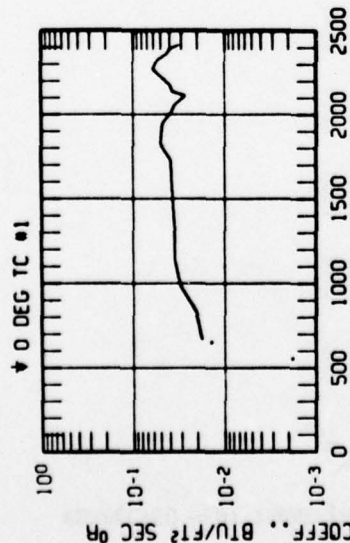
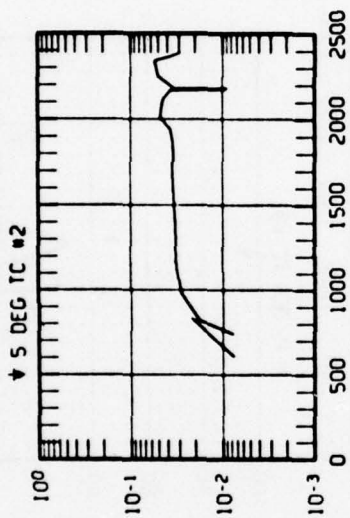
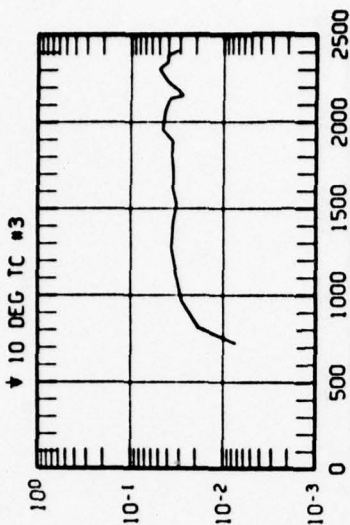
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CORRECTED HEAT TRANSFER, BTU/FT² SEC

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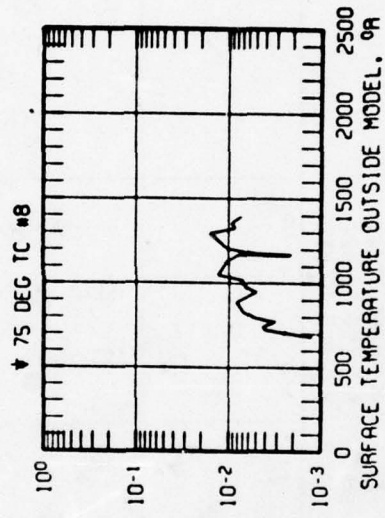
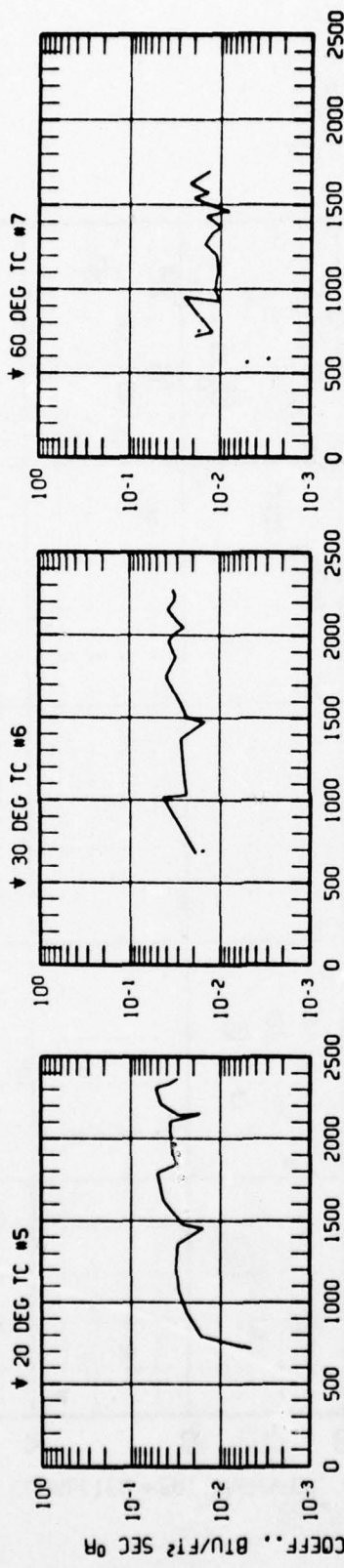
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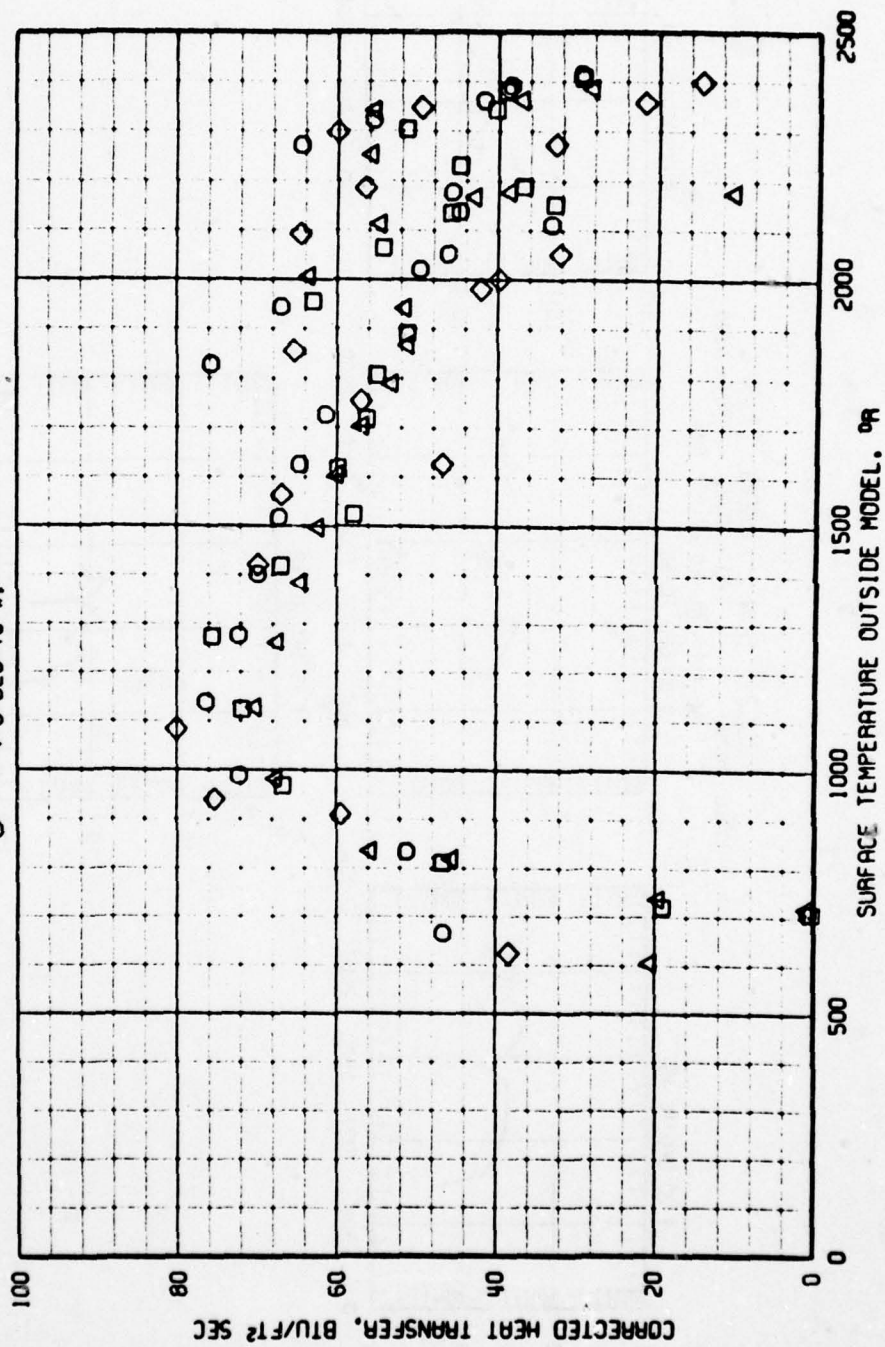
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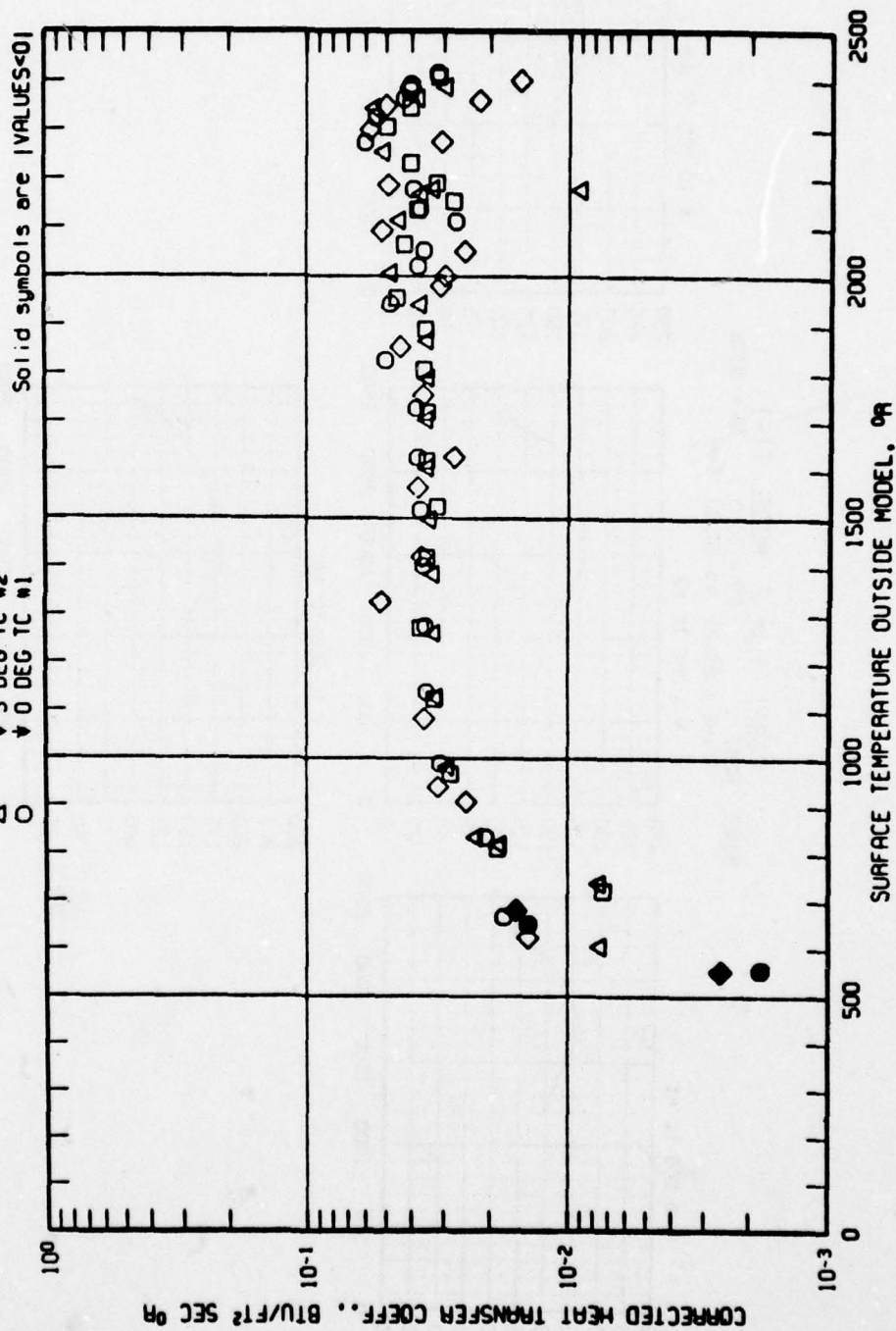
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 △ 5 DEG TC #2
 ○ 0 DEG TC #1

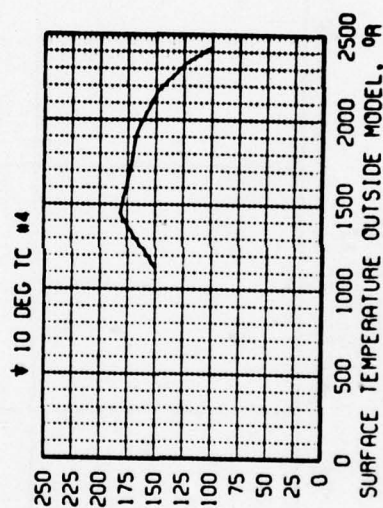
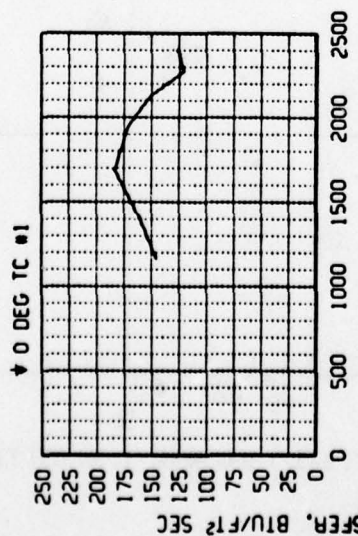
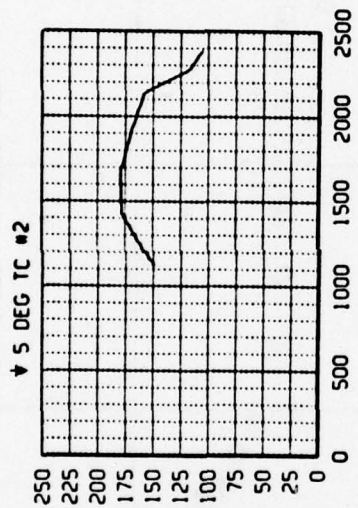
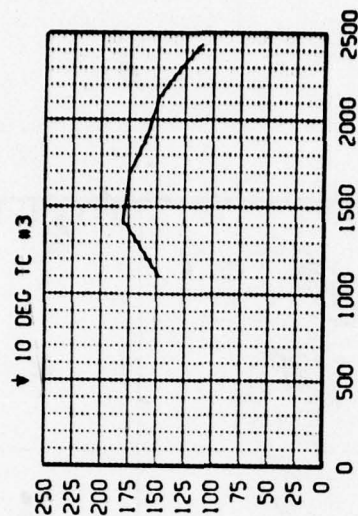


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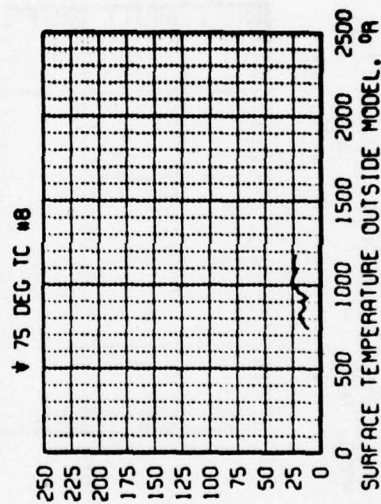
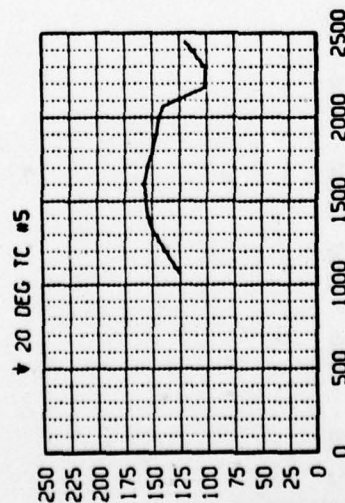
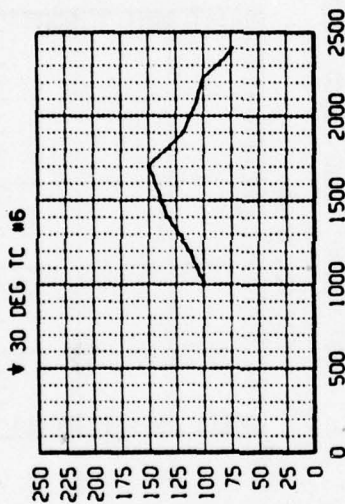
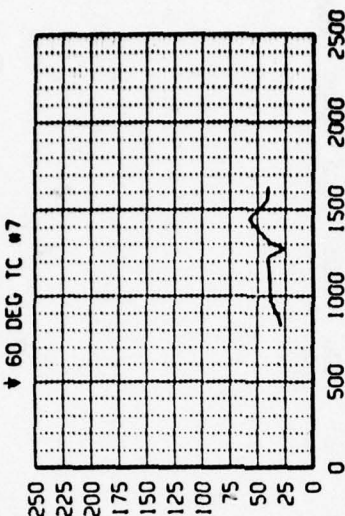


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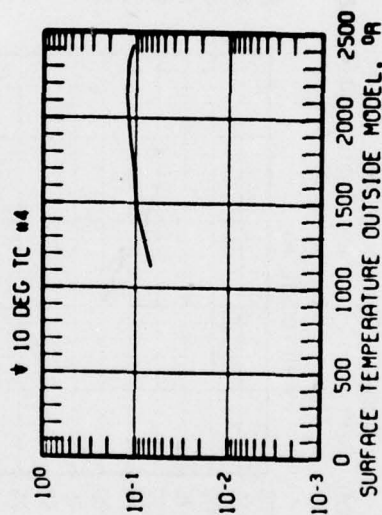
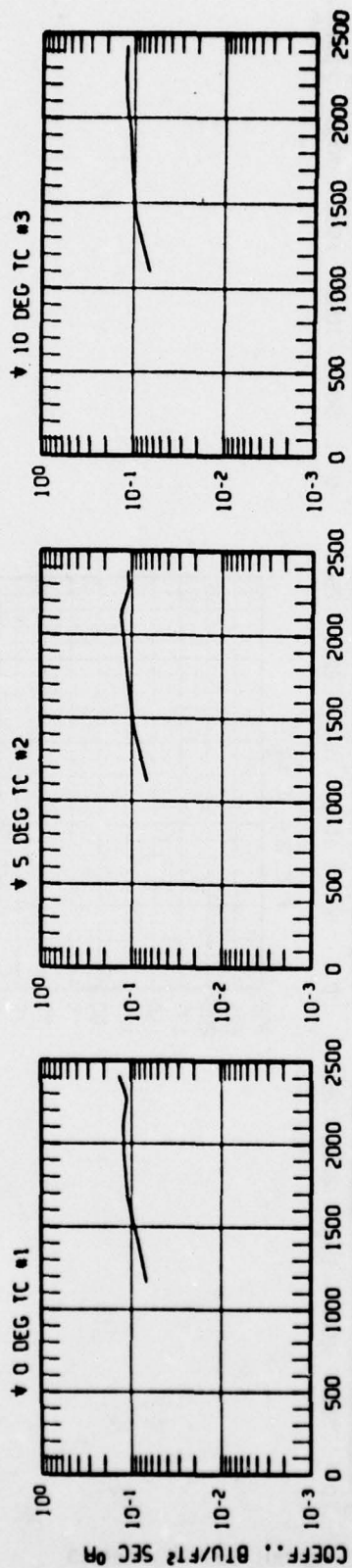
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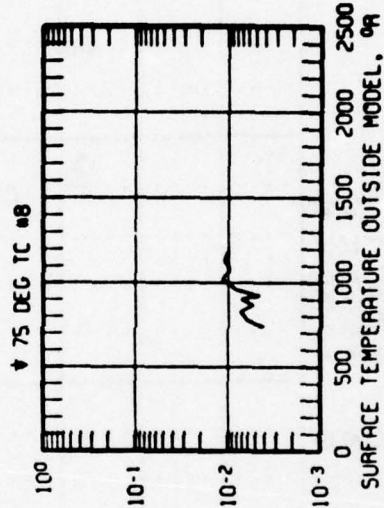
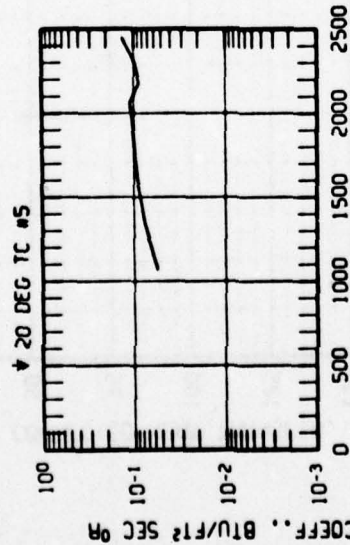
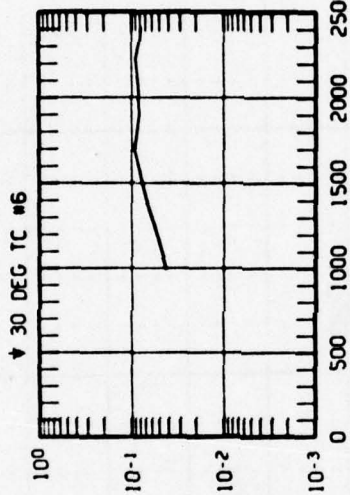
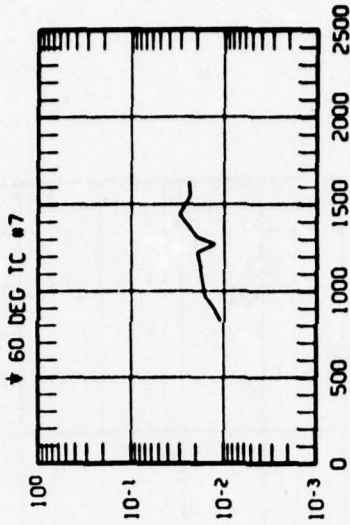
SURFACE TEMPERATURE OUTSIDE MODEL, °R

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 MODEL HEM1 P0 = 1000 T0 = 3348
 Time = 27.23 to 30.30 Sec



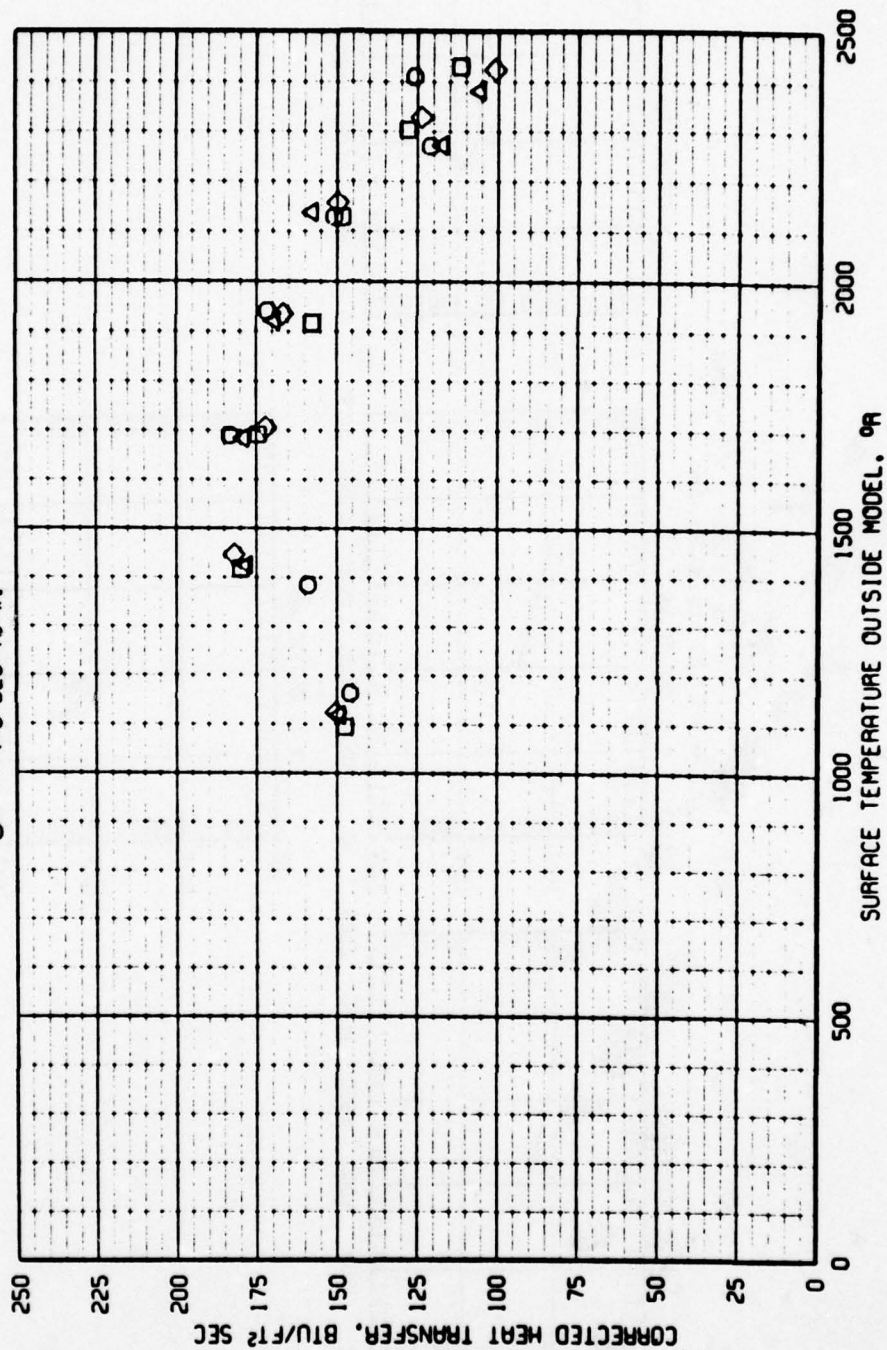
AD0021 RUN 2 MODEL T1-1
 MODEL HEMI PO = 1000 TO = 3348
 Time = 27.23 to 30.30 Sec



CORRECTED HEAT TRANSFER COEFF., BTU/FT² SEC °R

SURFACE TEMPERATURE OUTSIDE MODEL, °R

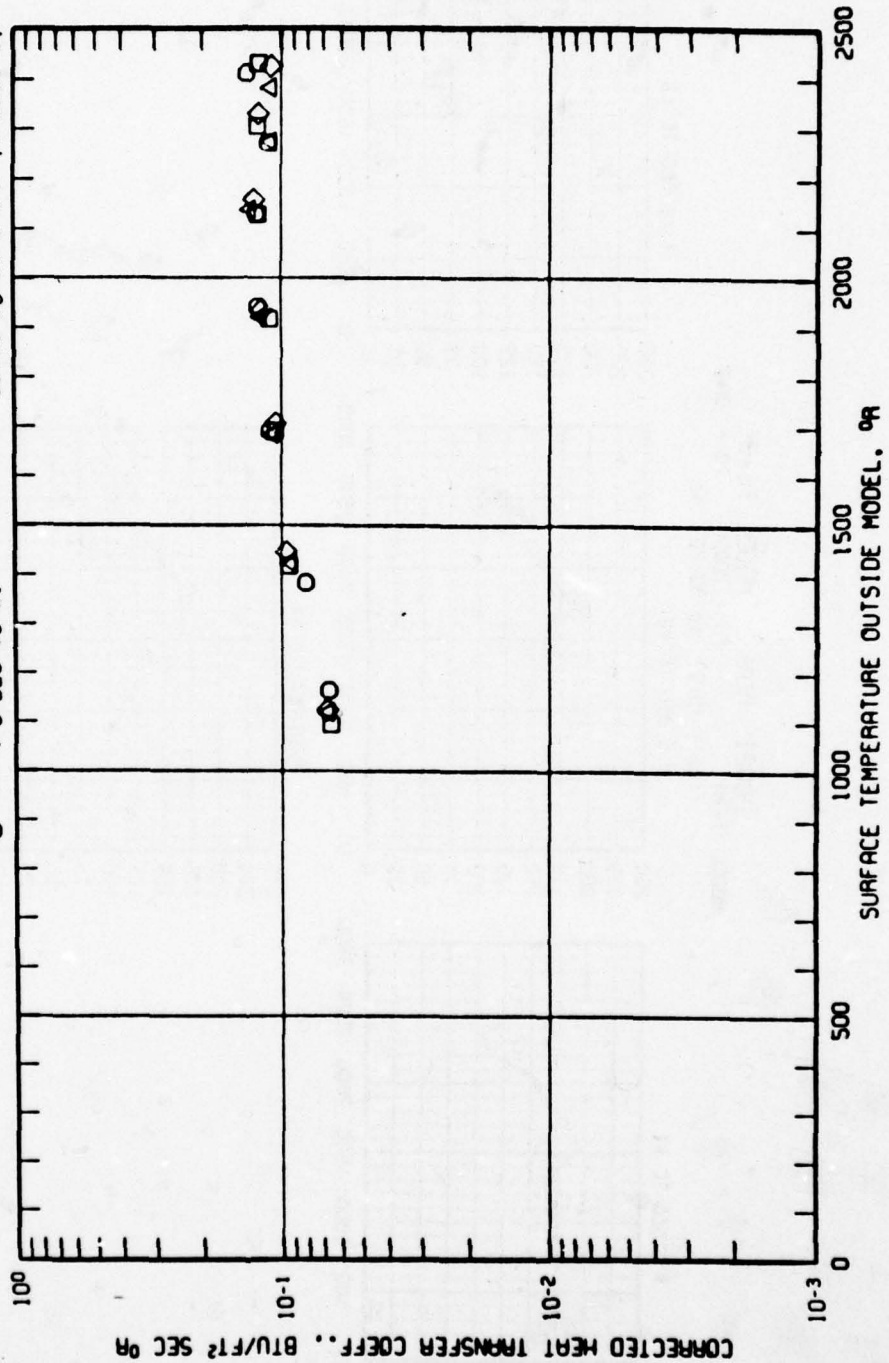
A0021 RUN 2 MODEL T1-1
 MODEL HEMI P0 = 1000 T0 = 3348
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 □ 10 DEG TC #3
 △ 5 DEG TC #2
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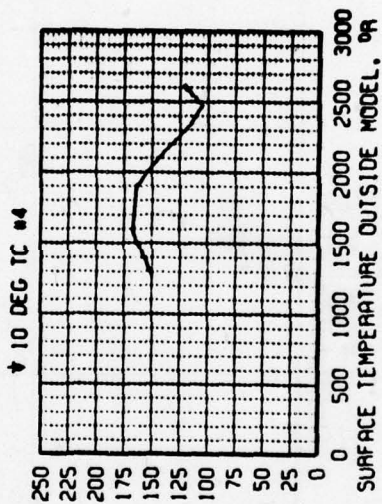
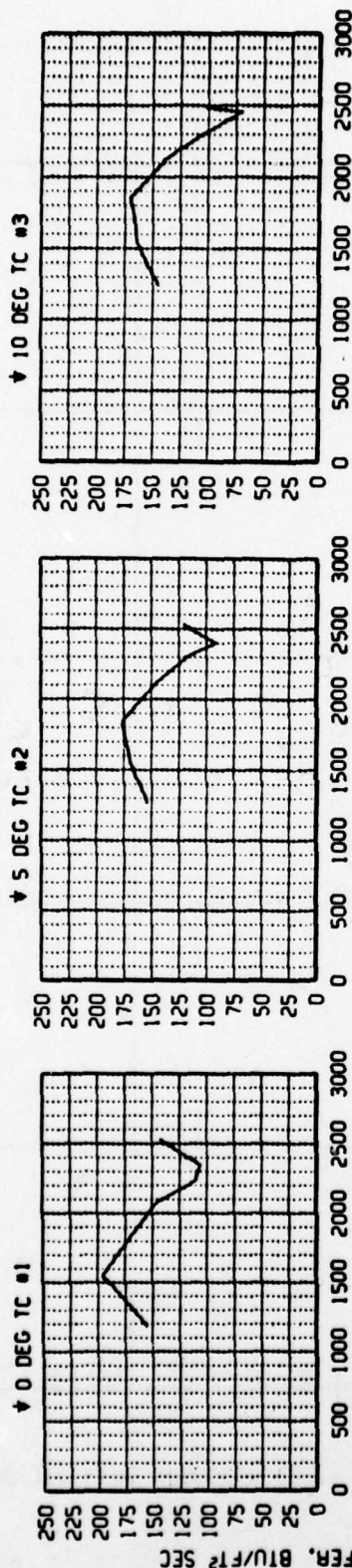
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Solid symbols are IVALUES<01

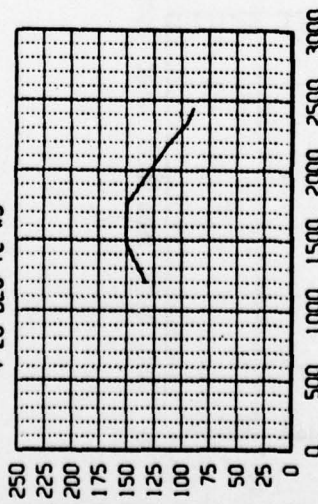


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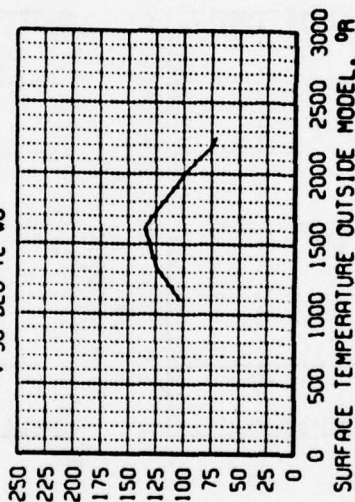


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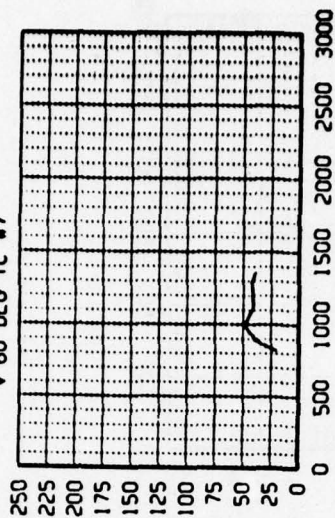
↓ 20 DEG TC #5



↓ 30 DEG TC #6

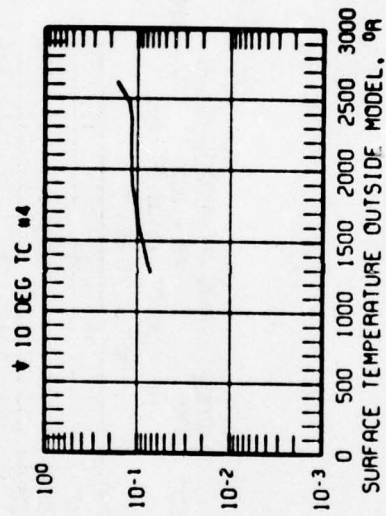
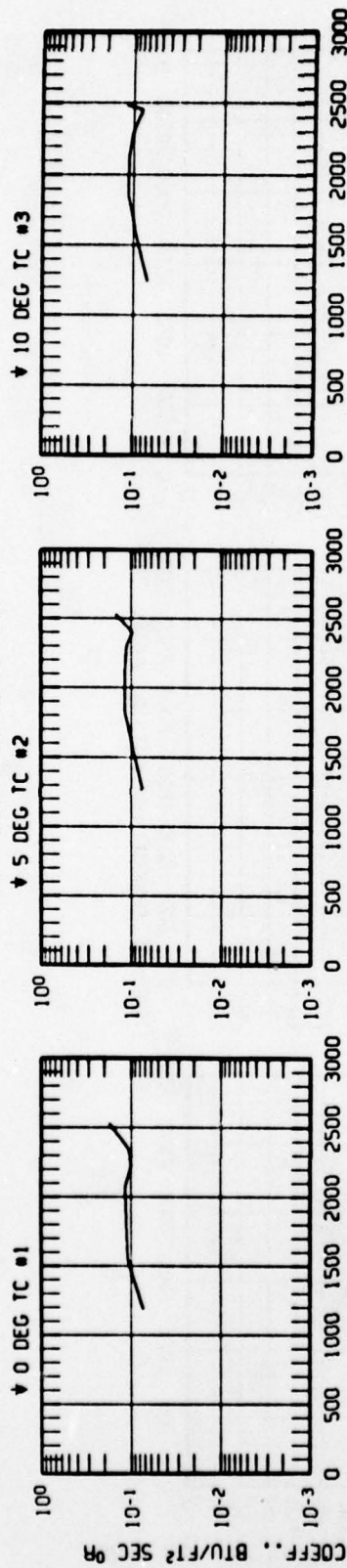


↓ 60 DEG TC #7

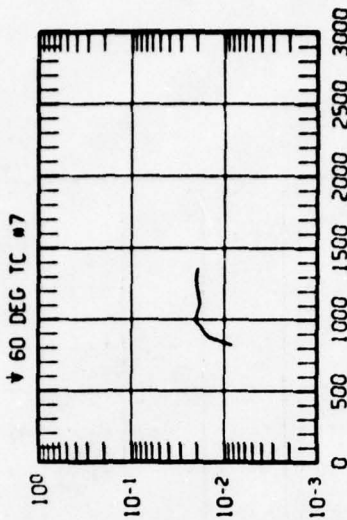
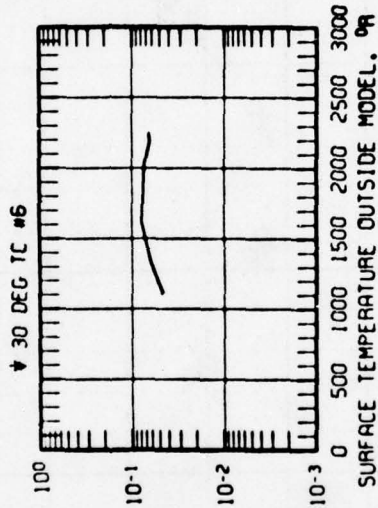
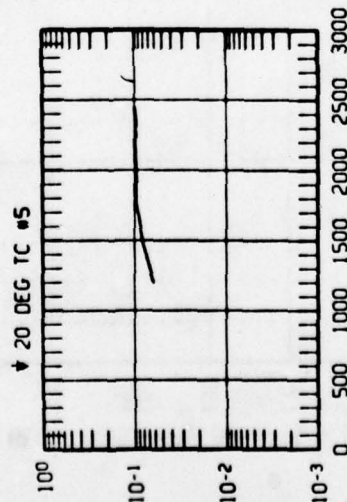


MODEL HEMI ADO21 RUN 2 MODEL T1-6
 P0 = 1000 T0 = 3348
 Time = 36.07 to 38.20 Sec

AD021 RUN 2 MODEL T1-6
 MODEL HEMI P0 = 1000 T0 = 3348
 Time = 36.07 to 38.20 Sec



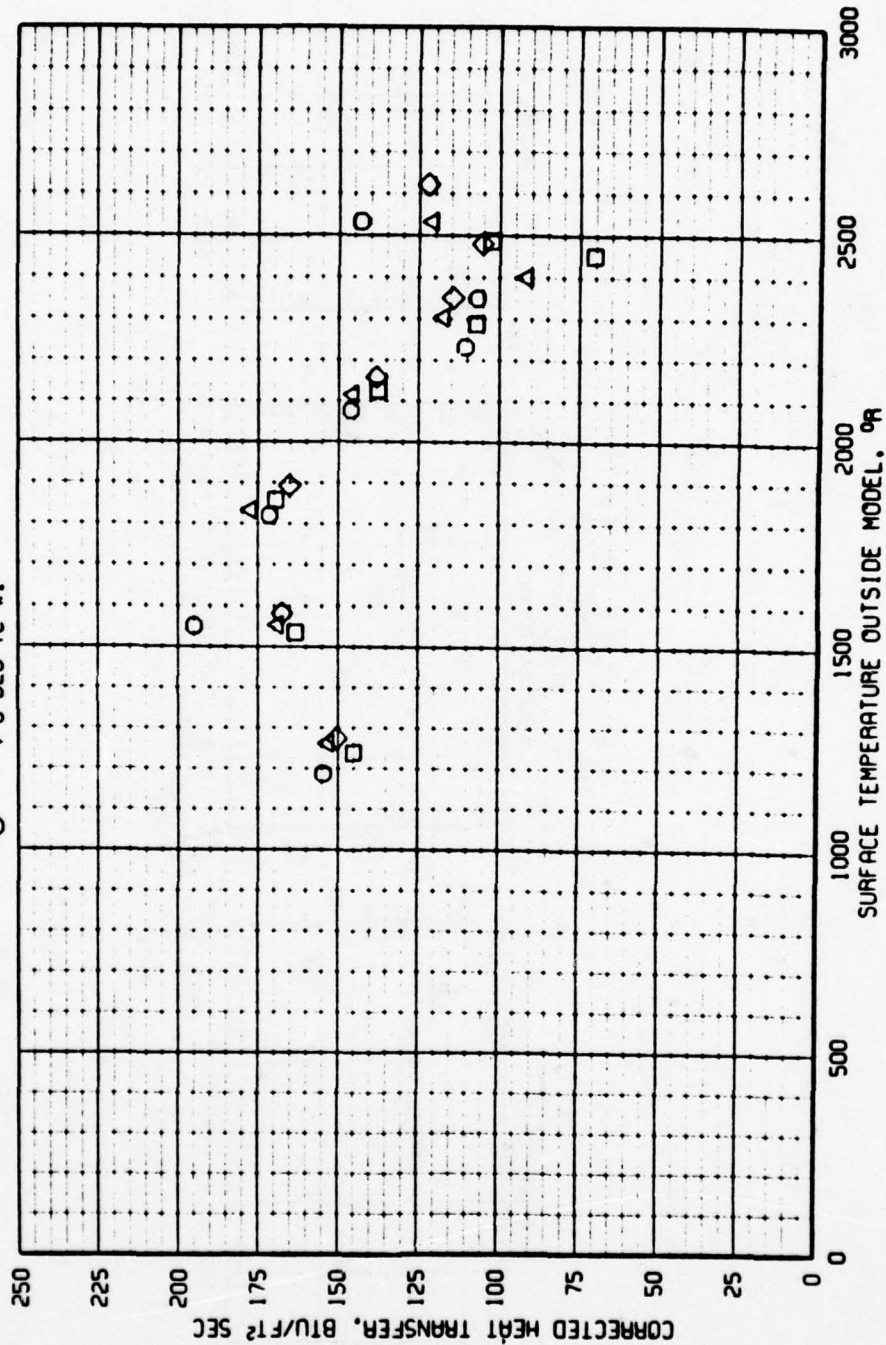
CORRECTED HEAT TRANSFER COEFF., BTU/FT² SEC °R



MODEL HEMI
 Time = 36.07 to 38.20 Sec
 PO = 1000 TO = 3348

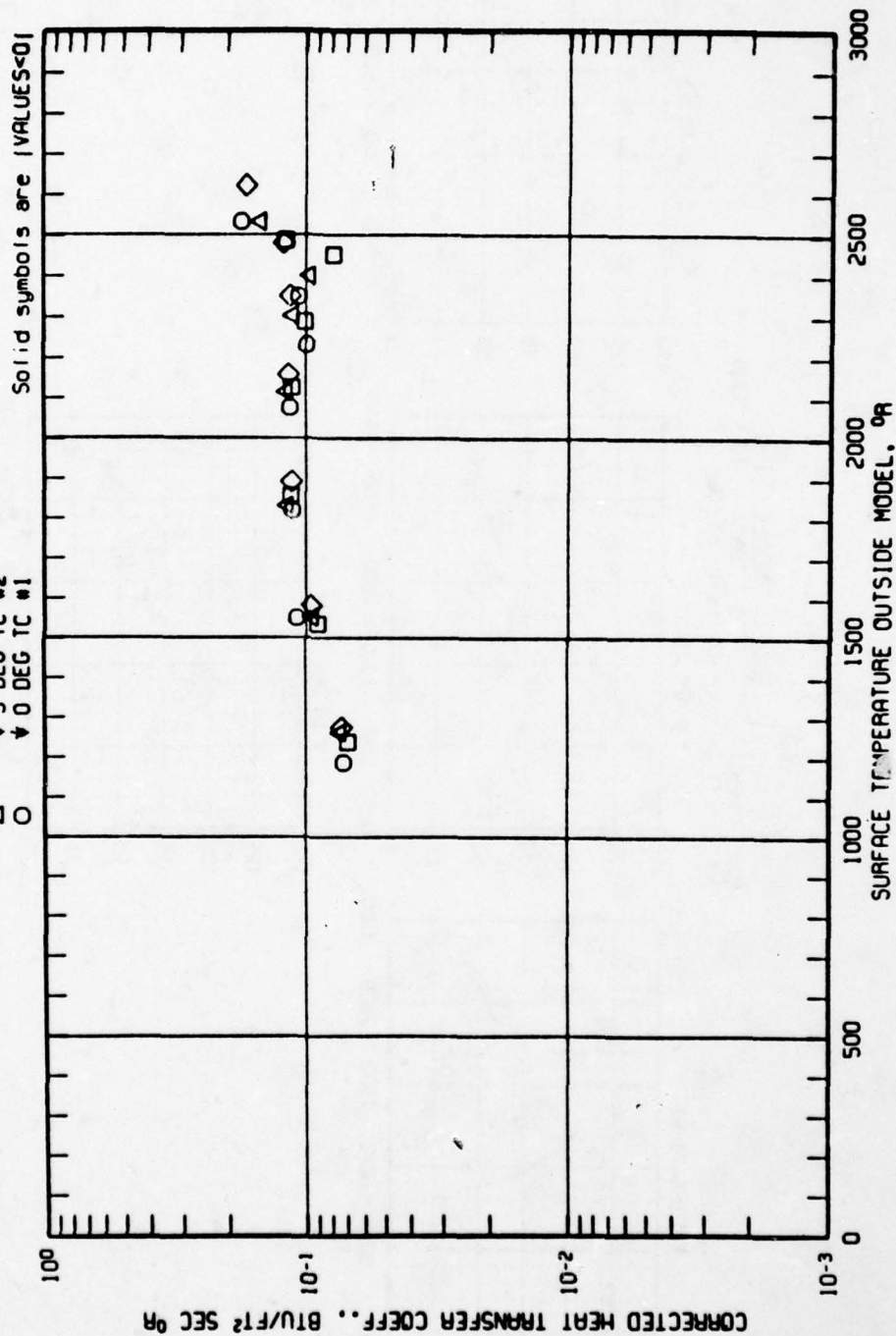
AD021 RUN 2 MODEL T1-6

ADD021 RUN 2 MODEL TI-6
 MODEL HEMI P0 = 1000 T0 = 3348
 Time = 36.07 to 38.20 Sec
 ◆ ▼ 10 DEG TC #4
 □ ▼ 10 DEG TC #3
 △ ▼ 5 DEG TC #2
 ○ ▼ 0 DEG TC #1

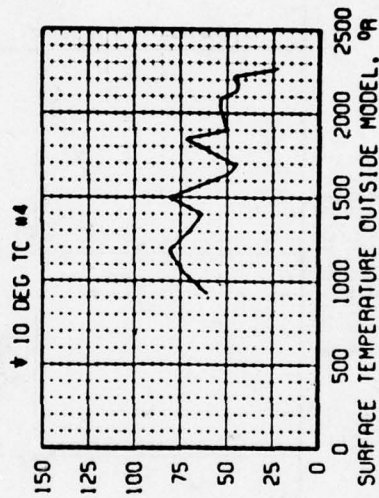
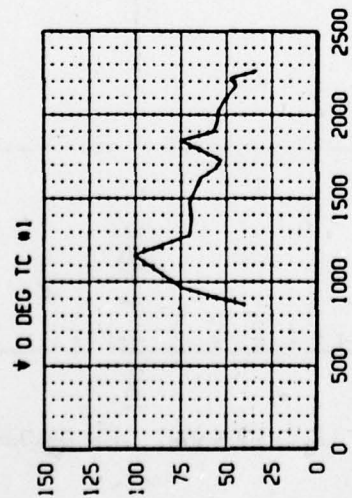
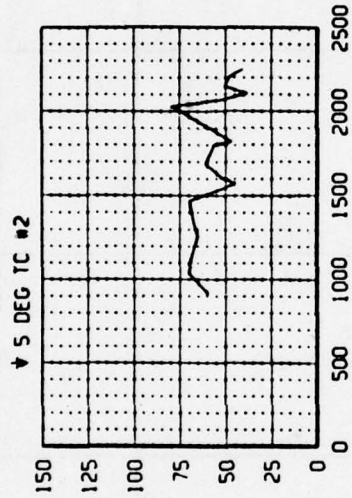
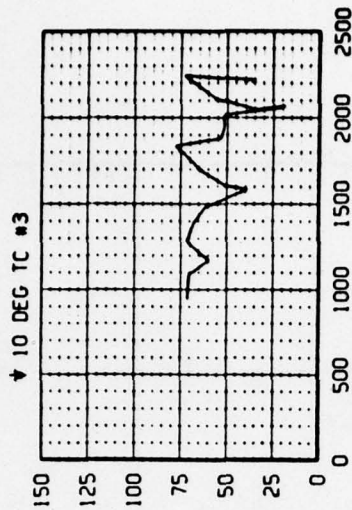


AD021 RUN 2 MODEL TI-6
 MODEL HEMI P0 = 1000 T0 = 3348
 Time = 36.07 to 38.20 Sec

◇ 10 DEG TC #4
 □ 10 DEG TC #3
 △ 5 DEG TC #2
 ○ 0 DEG TC #1



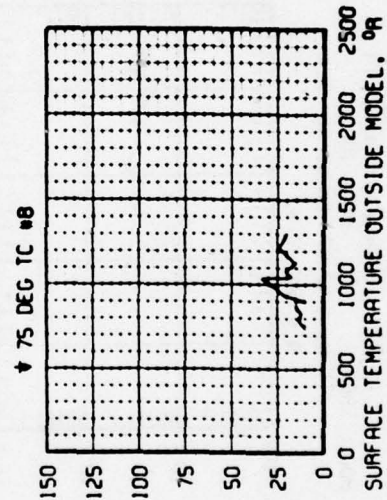
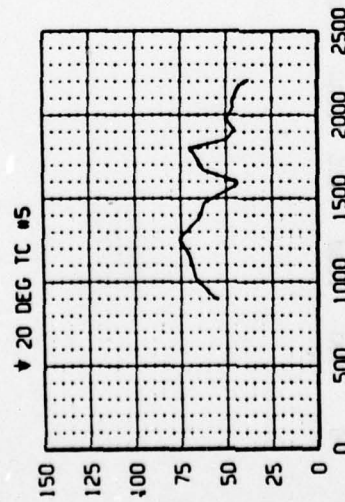
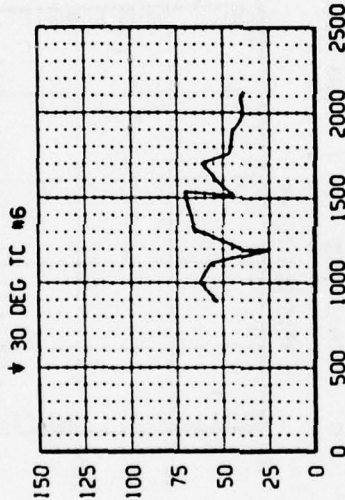
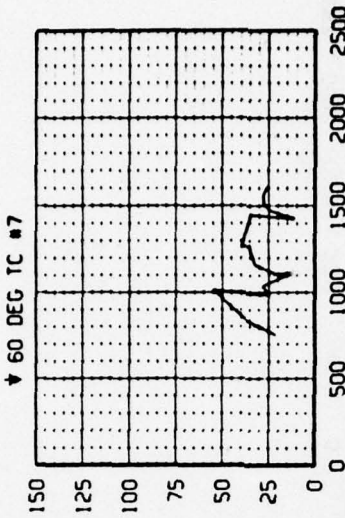
AD0021 RUN 2 MODEL T1-7
 MODEL HEM1 PO = 1000 TO = 3348
 Time = 42.97 to 48.00 Sec



SURFACE TEMPERATURE OUTSIDE MODEL, °R
 0 500 1000 1500 2000 2500

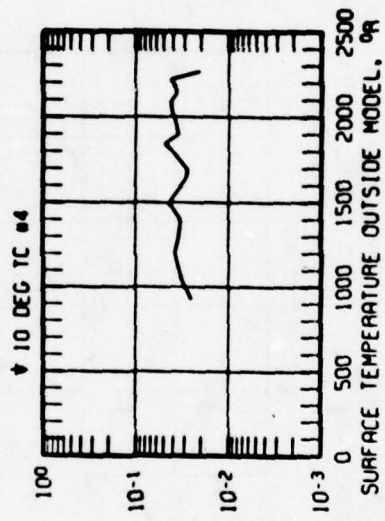
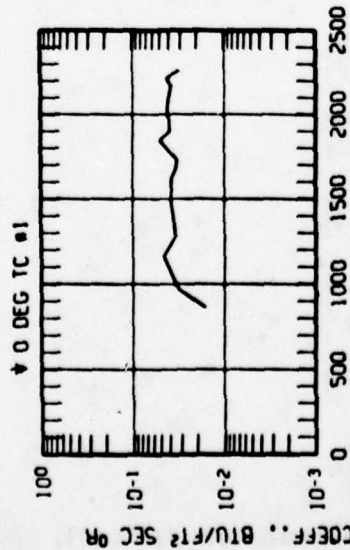
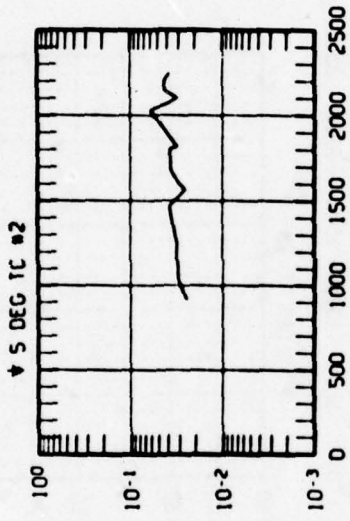
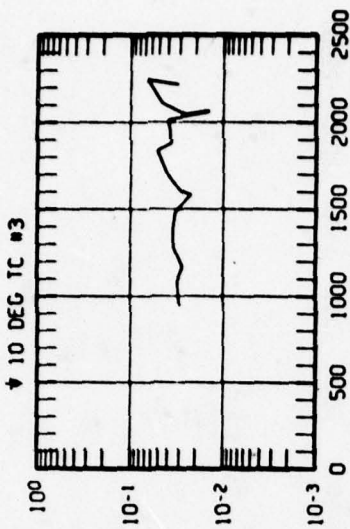
CORRECTED HEAT TRANSFER, BTU/FT² SEC

AD0021 RUN 2 MODEL T1-7
 MODEL HEMI P0 = 1000 T0 = 3348
 Time = 42.97 to 48.00 Sec



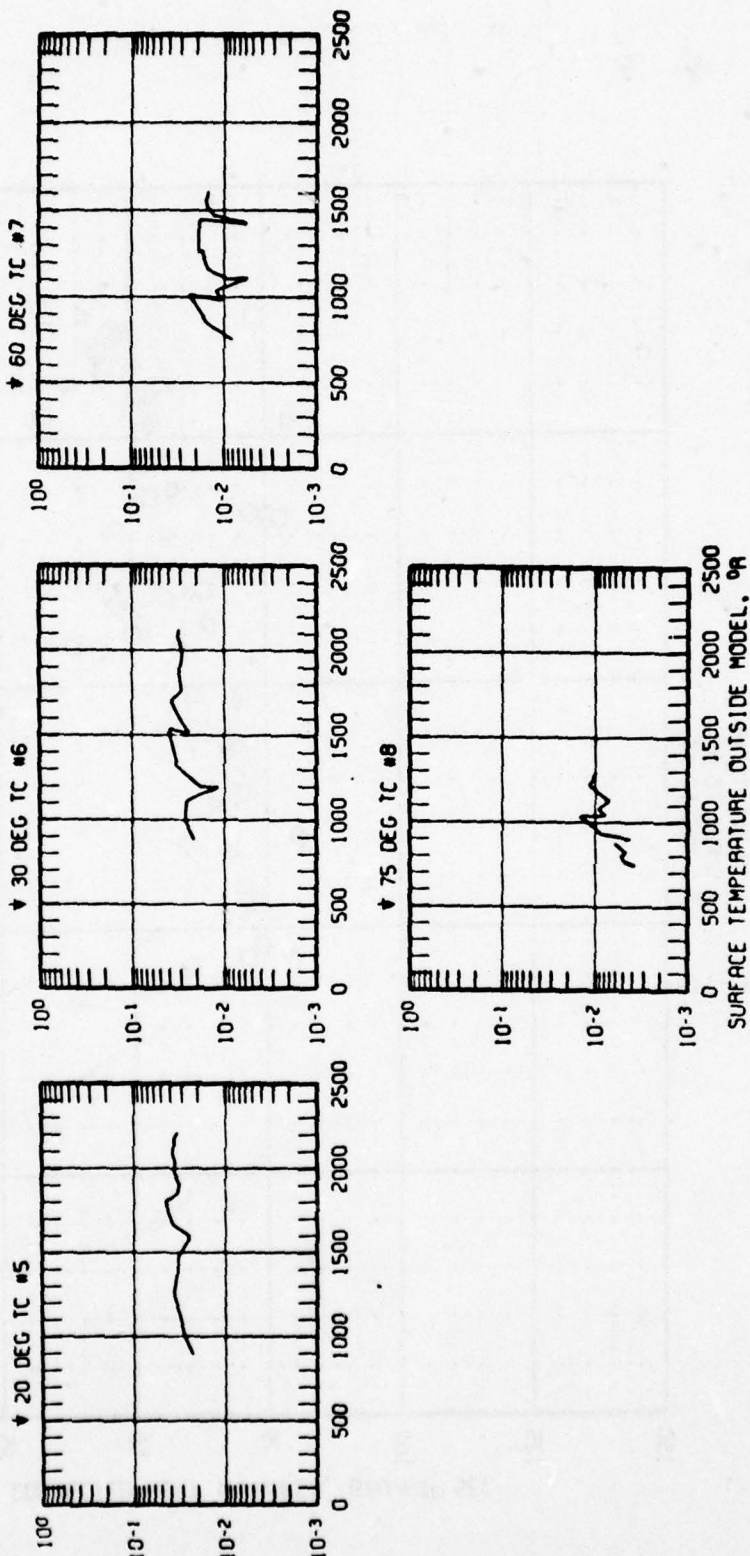
SURFACE TEMPERATURE OUTSIDE MODEL, °R

AD021 RUN 2 MODEL T1-7
 MODEL HEM1 P0 = 1000 T0 = 3348
 Time = 42.97 to 48.00 Sec



CORRECTED HEAT TRANSFER COEFF., BTU/FT² SEC °R

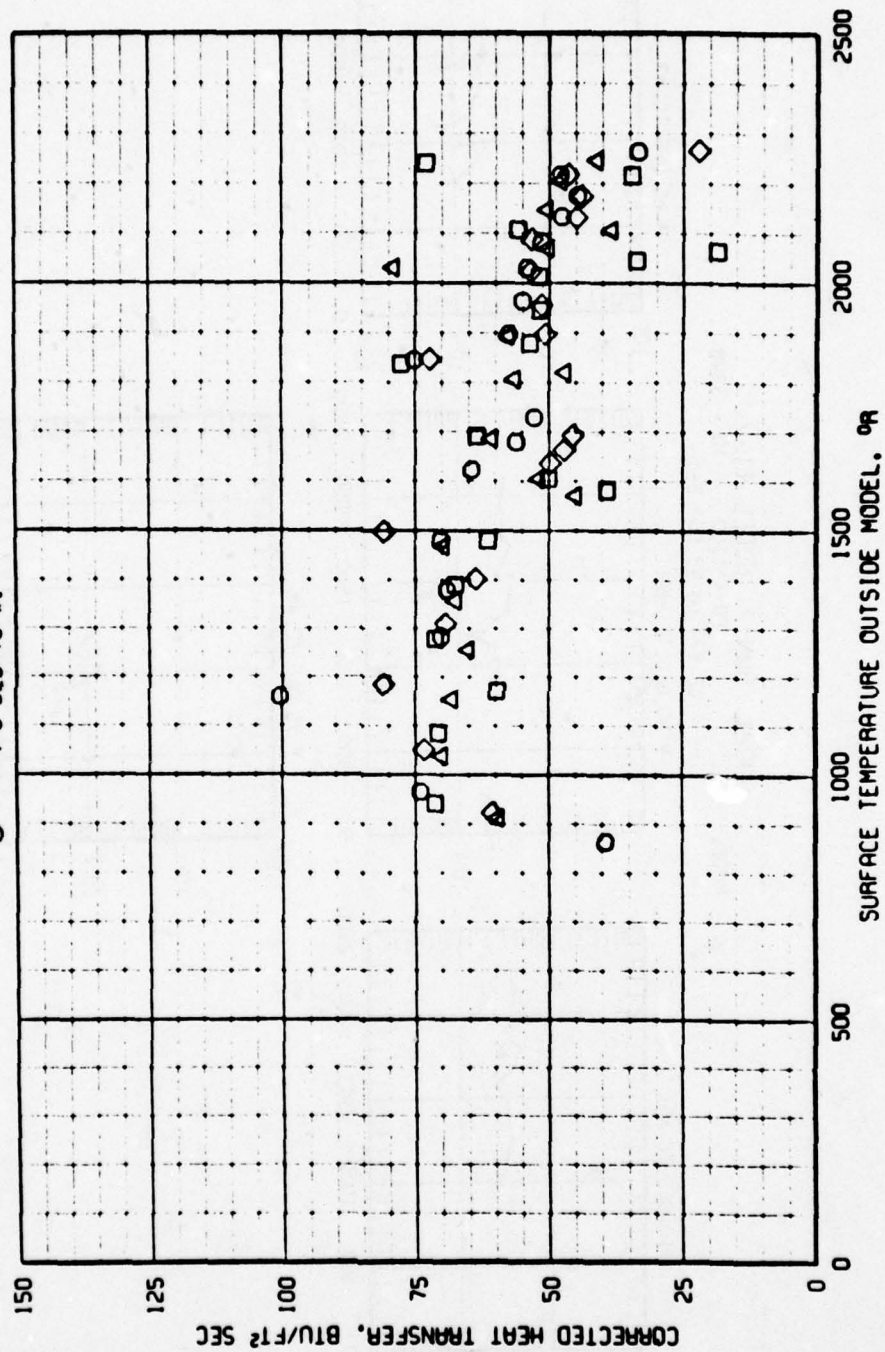
CORRECTED HEAT TRANSFER COEFF., BTU/FT² SEC °R



AD021 RUN 2 MODEL 11-7
 MODEL HEM1 P0 = 1000 T0 = 3348
 Time = 42.97 to 48.00 Sec

ADD021 RUN 2 MODEL T1-7
 MODEL HEMI PO = 1000 TO = 3348
 Time = 42.97 to 48.00 Sec

◇ 10 DEG TC #4
 □ 10 DEG TC #3
 △ 5 DEG TC #2
 ○ 0 DEG TC #1



A0021 RUN 2 MODEL TI-7
 MODEL HEMI P0 = 1000 T0 = 3348
 Time = 42.97 to 48.00 Sec

◇ 10 DEG TC #4
 □ 10 DEG TC #3
 △ 5 DEG TC #2
 ○ 0 DEG TC #1

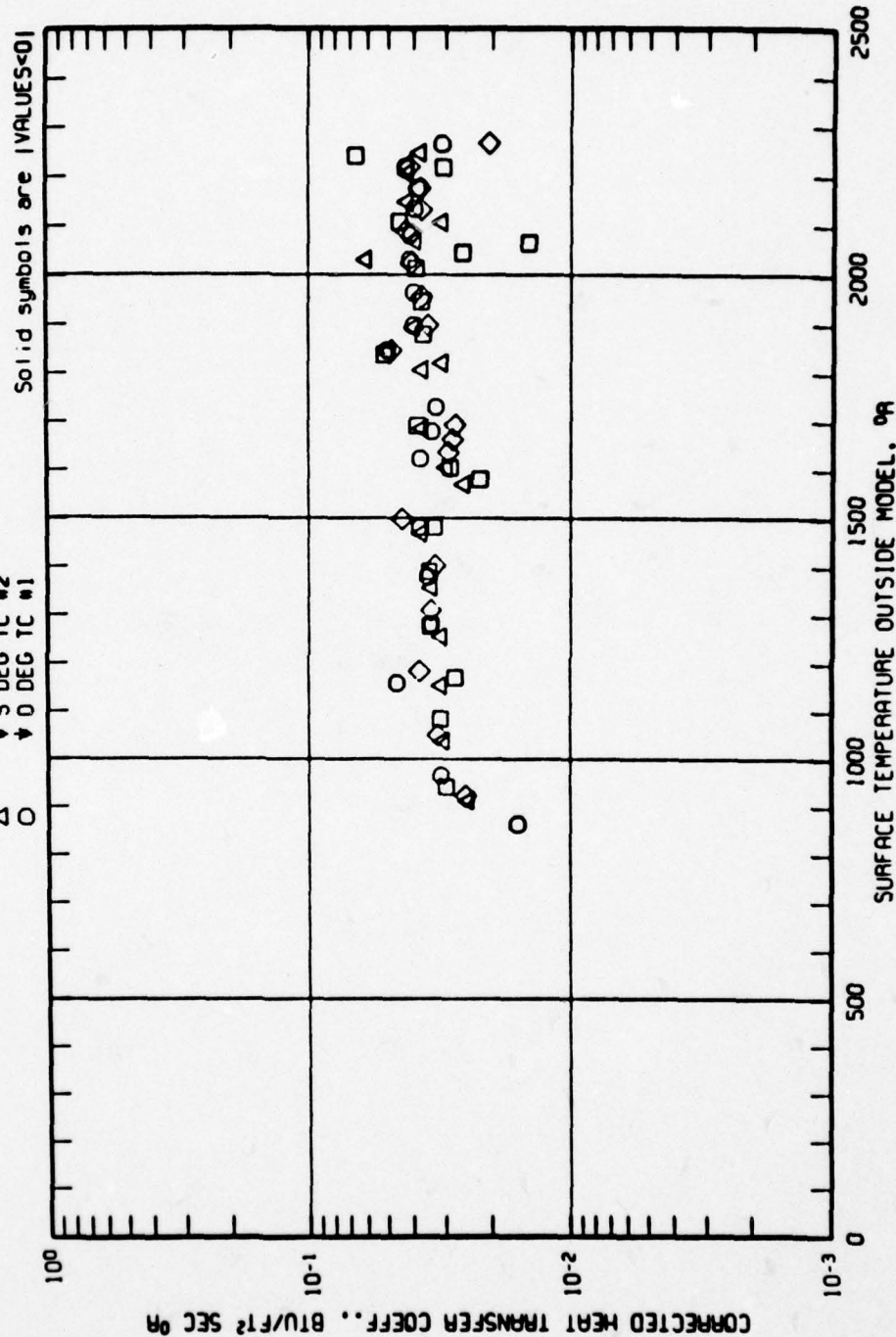


TABLE 1 RUN SUMMARY
RUN 3 DATE 12-1-76

TEST CONDITIONS

$P_0 = 1000$ psia, $P_{0m} = 1000.5$

$H_{0g} = 592$ 8tu/lbm, $H_{0m} = 576$

$H_0 = 580$ 8tu/lbm

$T_{0g} = 2300$ °R, $T_0 = 2269$ °R

$M = 7.3$ $P_0' = 10$ psia

NOZZLE STATION 127.5

DUST
MgO
100
4200
13.93
44.7

WATER
Flow
C.F.
Orifice
804
psi

TYPE
SIZE
VEL
Flow
C.F.

Flow
C.F.
Orifice
804
psi

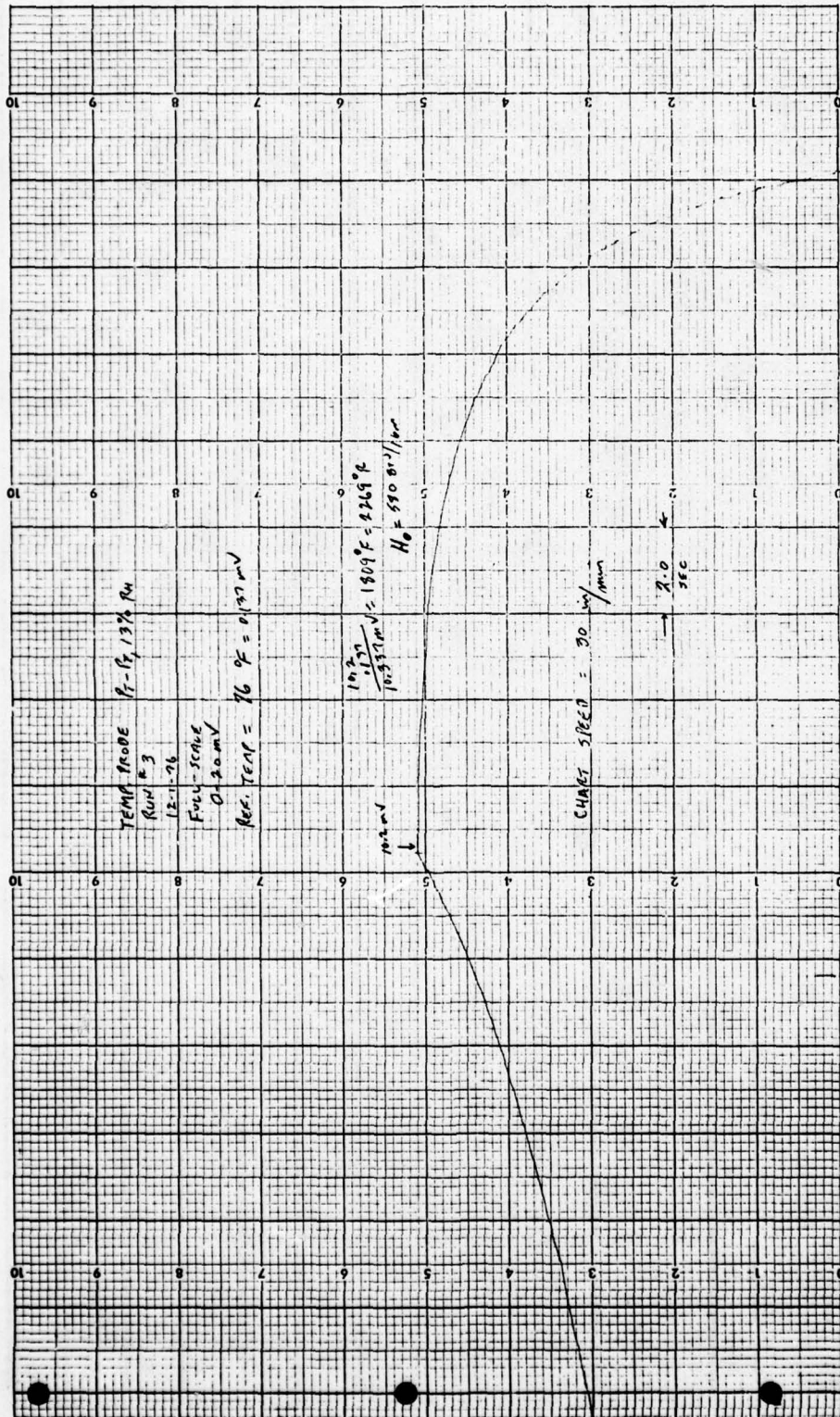
S N	MODEL NUMBER	EXPOSURE TIME				MODEL DESCRIPTION			MODEL INSTRUMENTATION				PHOTOGRAPHS			
		PH	DUST	H ₂ O	DUST & H ₂ O	POH	GEOMETRY	DIAM, in.	MATERIAL	T/C TYPE	NO. OF T/C's	PR. TAP	NO. OF TAPS	TRANS DOUGER TYPE	PRERUN	POSTRUN
1	Po probe	5					See Fig. 3	1.0	SS			x	1	Strain Gage		
2	To probe	15					See Fig. 3	0.25		R	1					
3	T _i -10	6.1					Hemi	2.0	6A1-4V- T _i	S	8				6838	
4																
5	T _i -5		5.77				Hemi	2.0	6A1-4V- T _i	S	8					8008
6																
7	T _i -8		5.07	7.00	X 5.07		Hemi	2.0	6A1-4V- T _i	S	8				6835	8007
8	T _i -11			5.85			Hemi	2.0	6A1-4V- T _i	S	8				6838	8005
9	WB-4R			6			See Fig. 2	2.0	A1							8006
10																

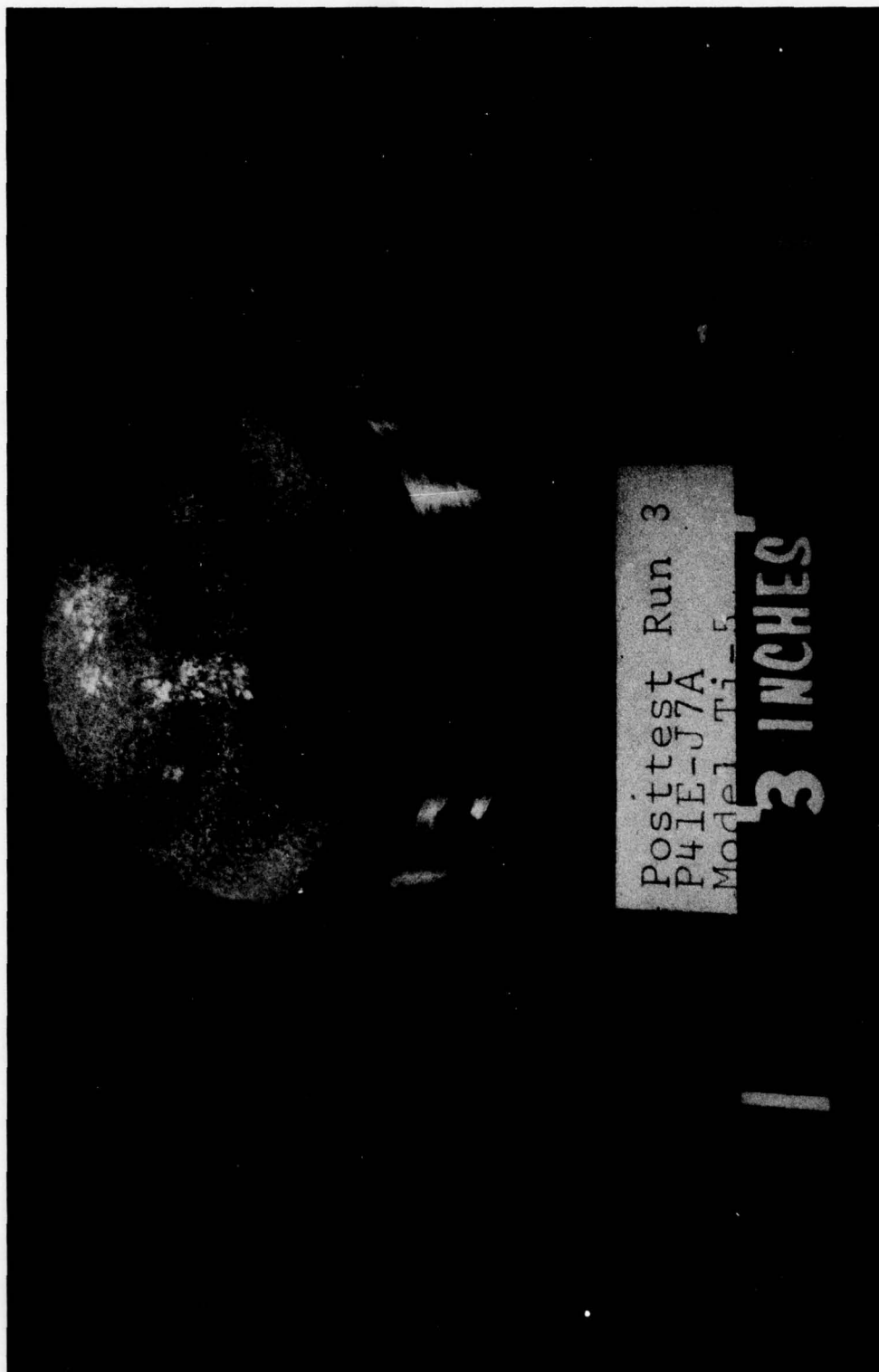
KEY -

PH - PREHEAT
POH - POSTHEAT
DUST AND H₂O - IF CHECKED, MEANS DUST AND WATER FLOWING AT SAME TIME

NOTES:

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FROM COPY FURNISHED TO DDC



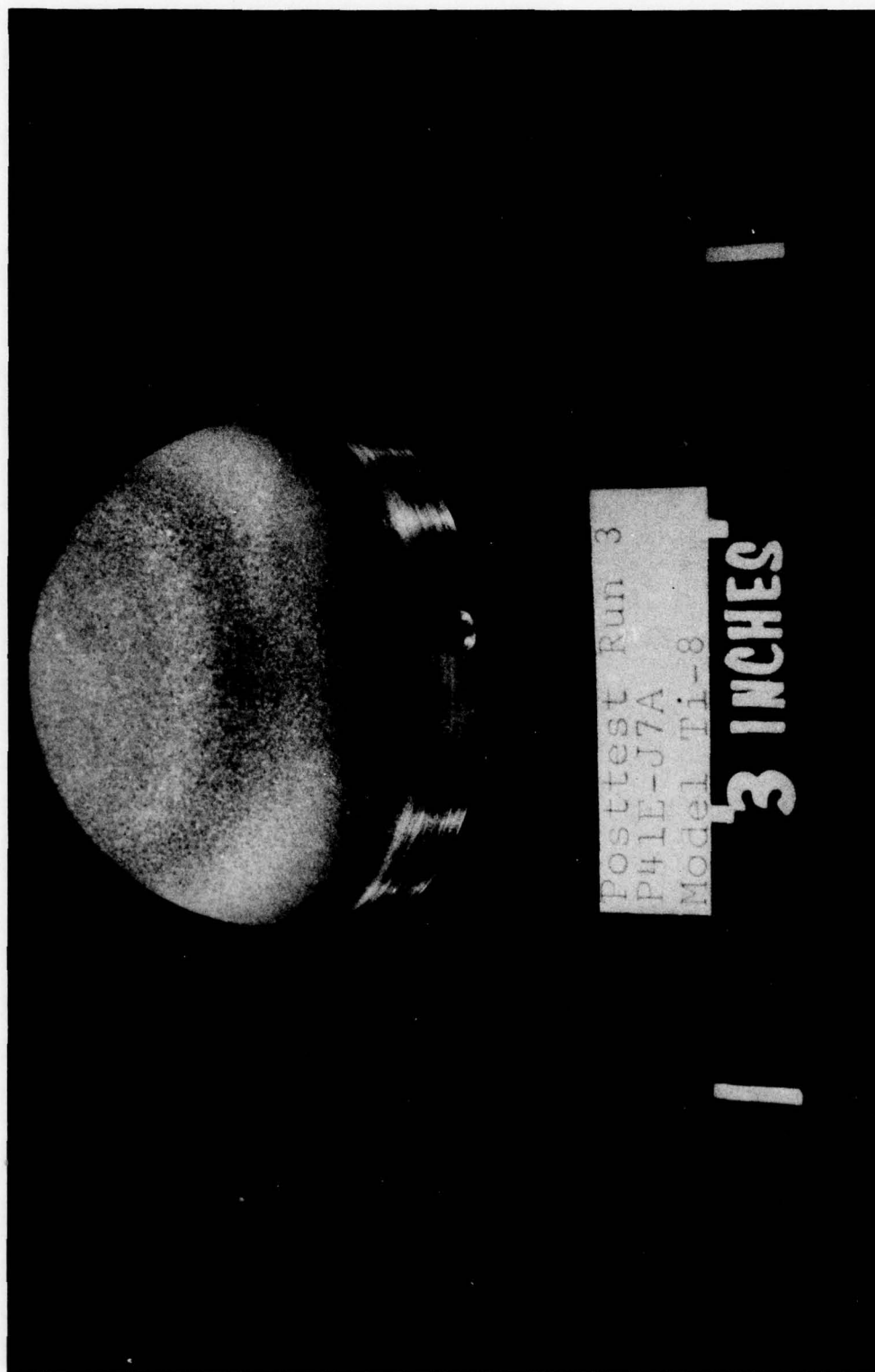


Posttest Run 3

P41E-J7A

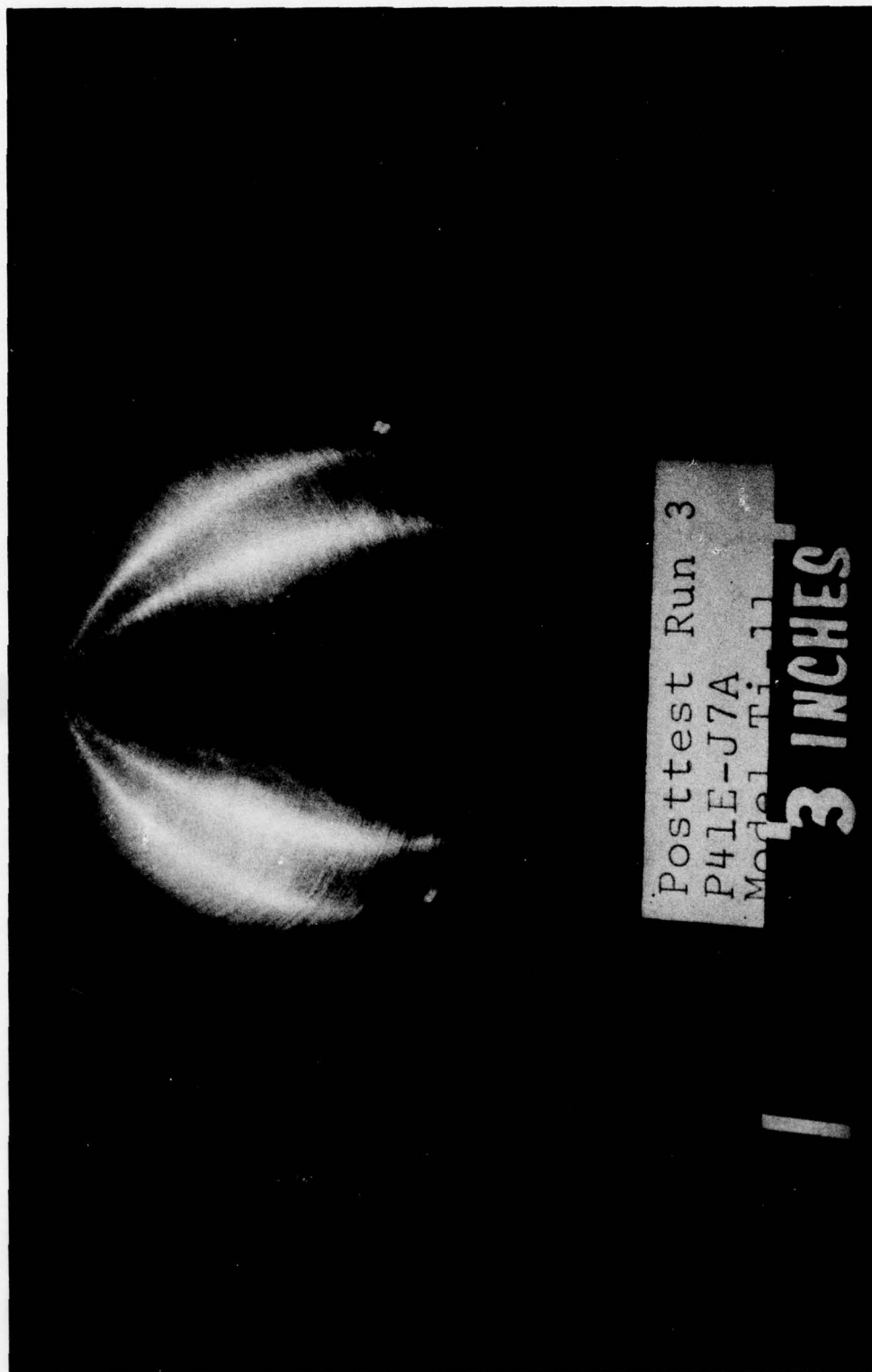
Model Ti-5

3 INCHES



Posttest Run 3
P41E-J7A
Model Ti-8

3 INCHES



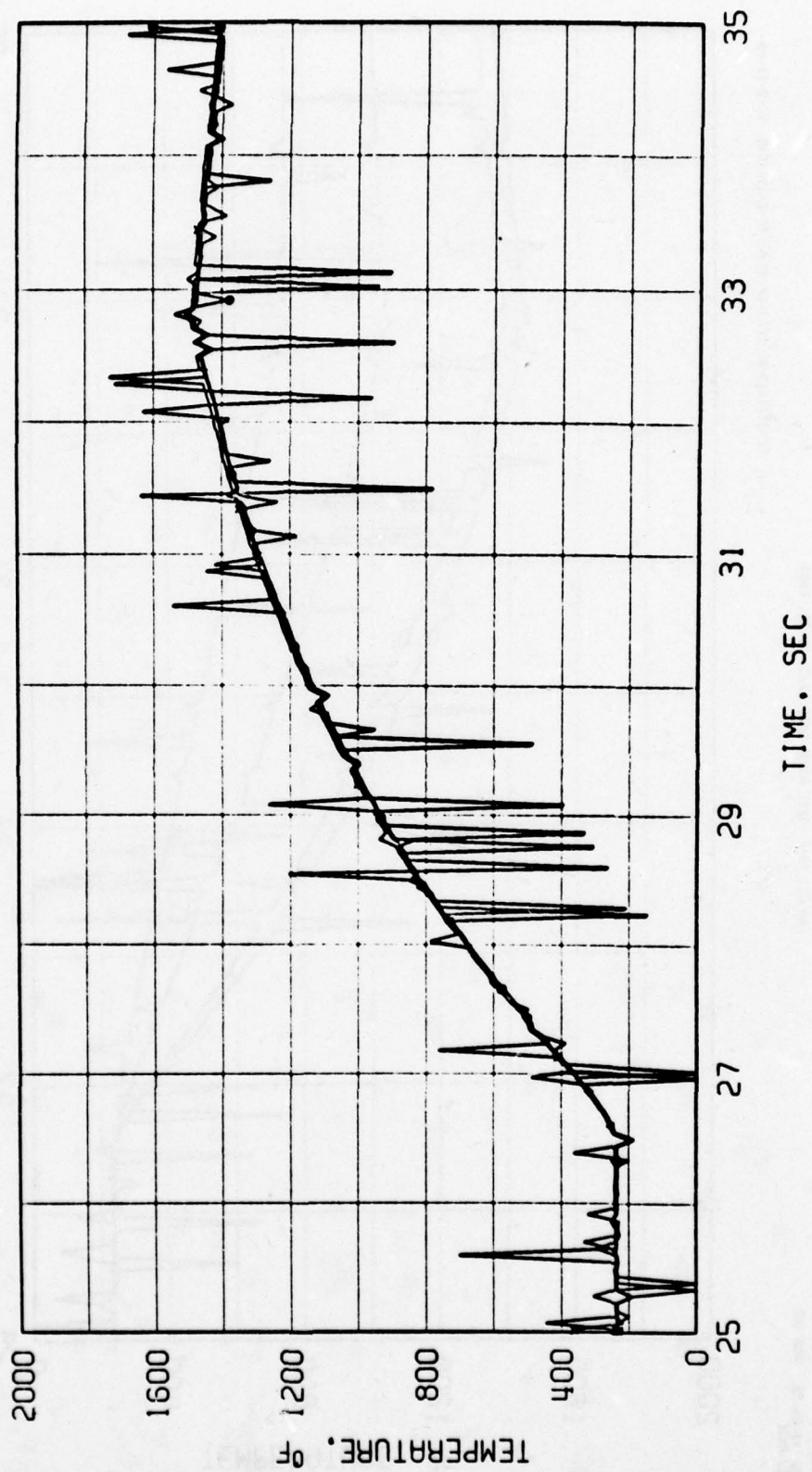
Posttest Run 3
P41E-J7a
WB-4R

3 INCHES

DATE 12-03-76 GPO INC
PROJ-PNIE

PROJECT PNIE TEST R0021 DATE 12-01-76 SEL 2103

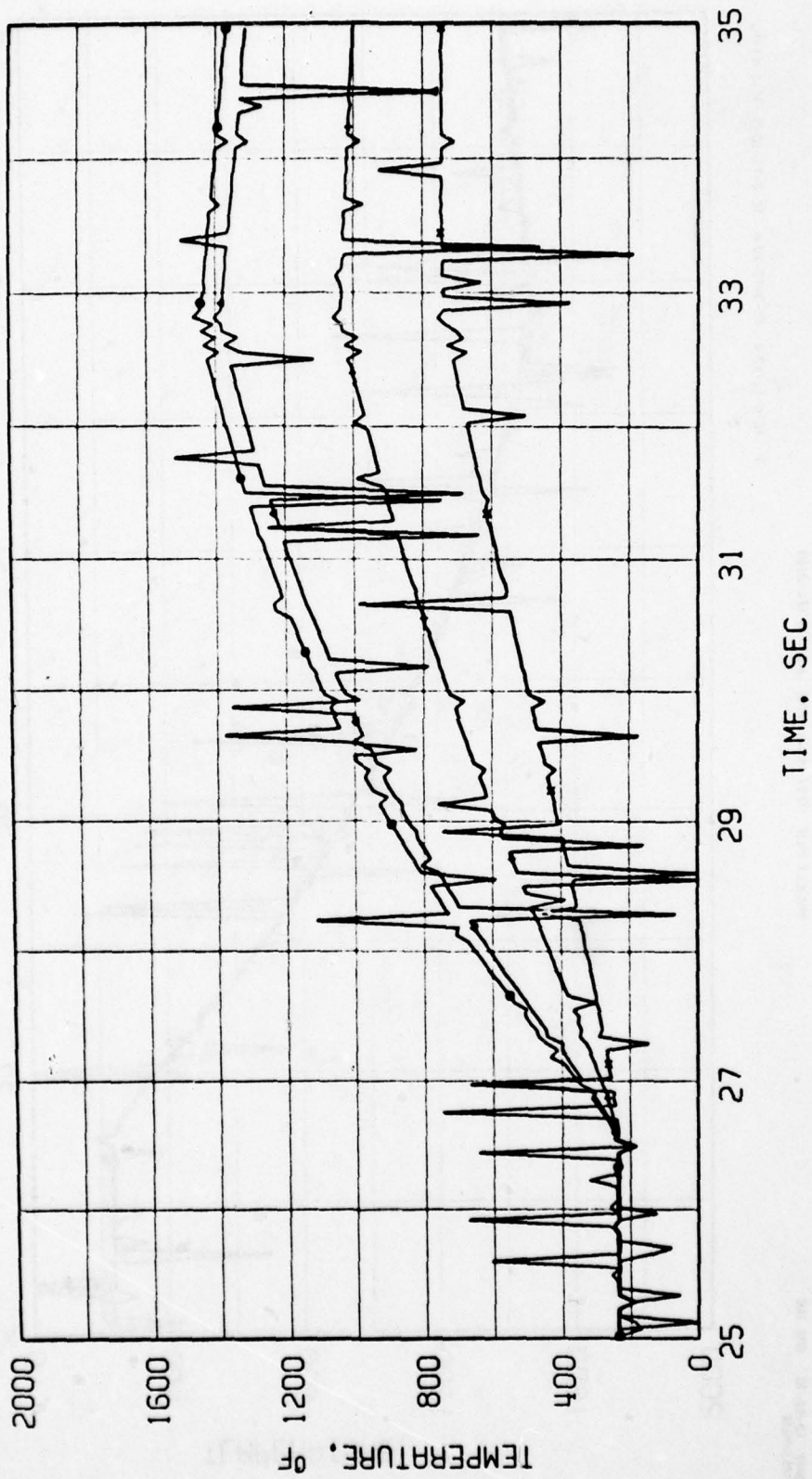
X TC-4-TI-10 + TC-3-TI-10 ▲ TC-2-TI-10 ○ TC-1-TI-10



DATE 12-03-76 RND INC
PROJ-PNIE

PROJECT PNIE TEST R0021 DATE 12-01-76 SEL 2103

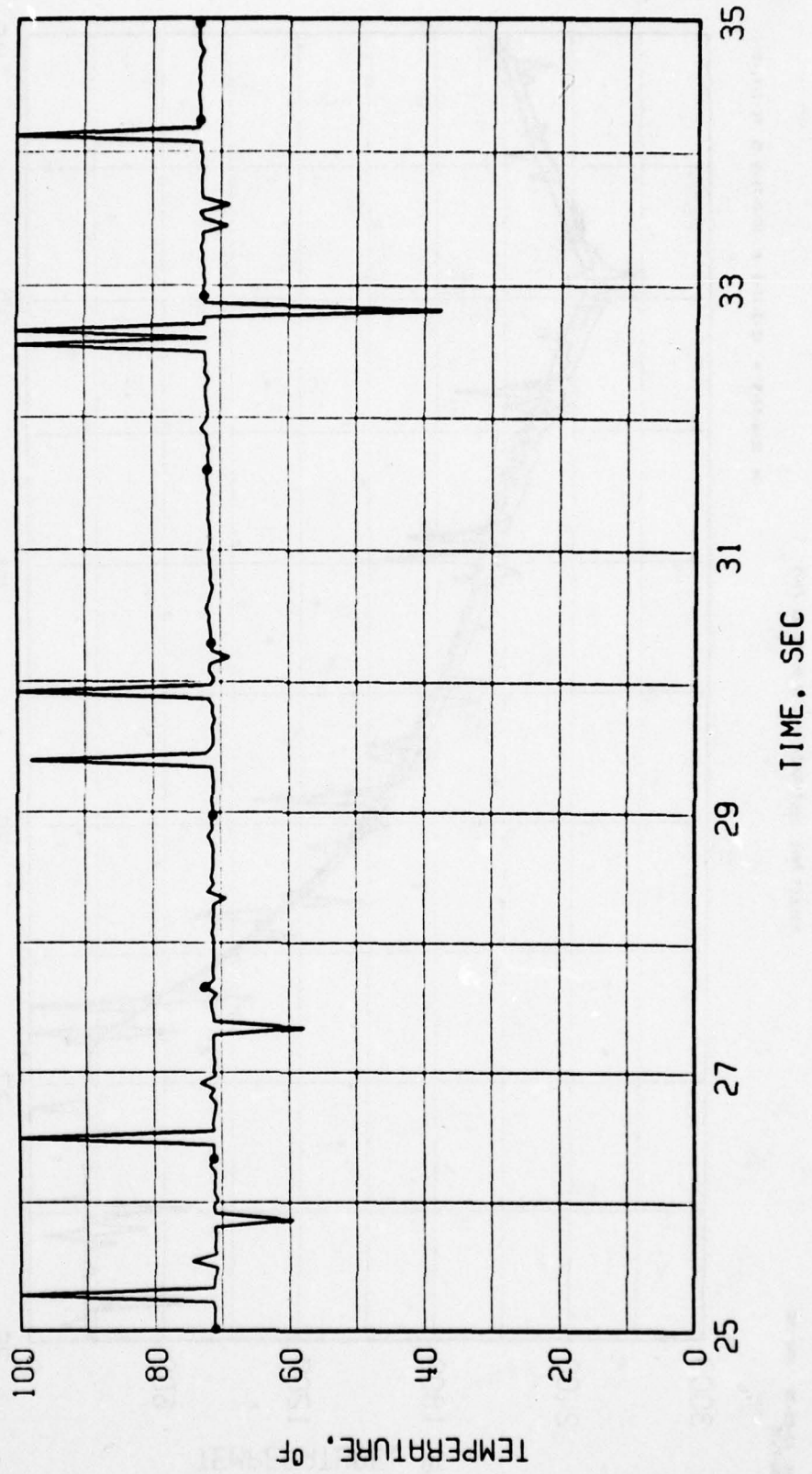
x TC-6-TI-10 + TC-7-TI-10 ▲ TC-6-TI-10 ○ TC-5-TI-10



DATE 12-03-76 GAO INC
PROJECT PNIE

PROJECT PNIE TEST 00021 DATE 12-01-76 SEL 2103

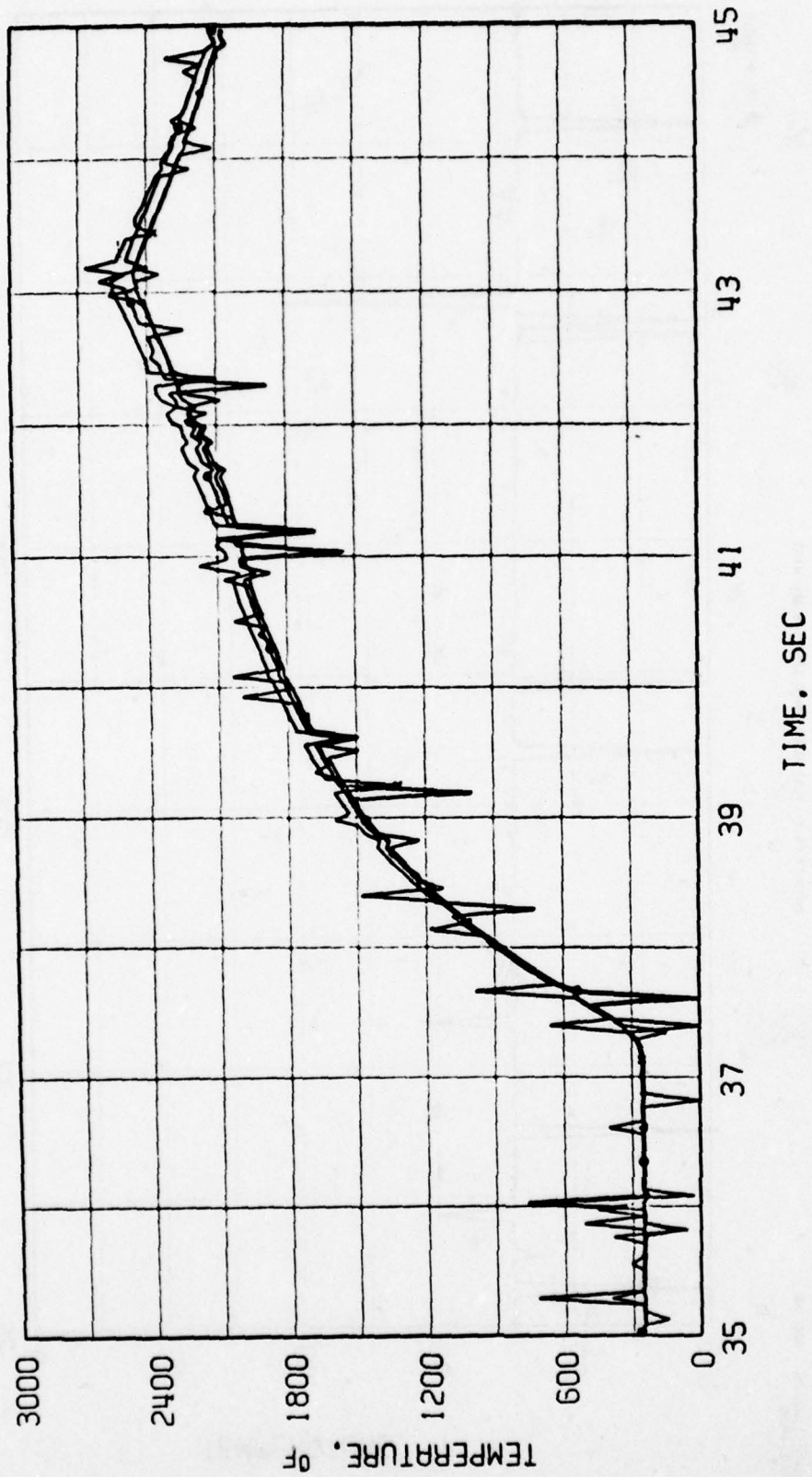
TC-9-T1-10



DATE 12-03-76 GMD INC
PROJ-PNIE

PROJECT PNIE TEST ROOM1 DATE 12-01-76 SEL 2109

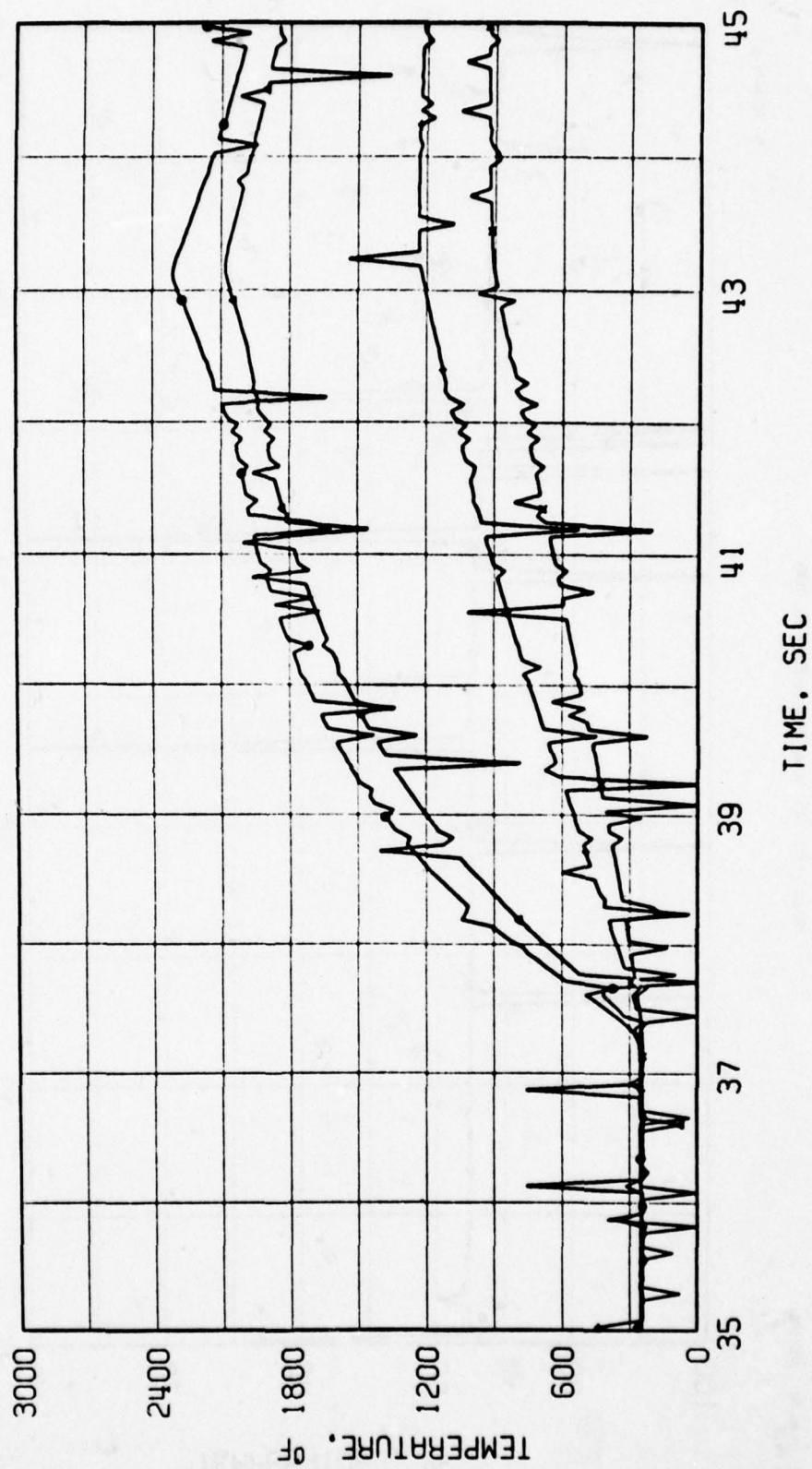
x TC-4-TI-S + TC-3-TI-S ▲ TC-2-TI-S ○ TC-1-TI-S



DATE 12-03-76 GND INC
PROJ-PNIE

PROJECT PNIE TEST R0021 DATE 12-01-76 SEL 2109

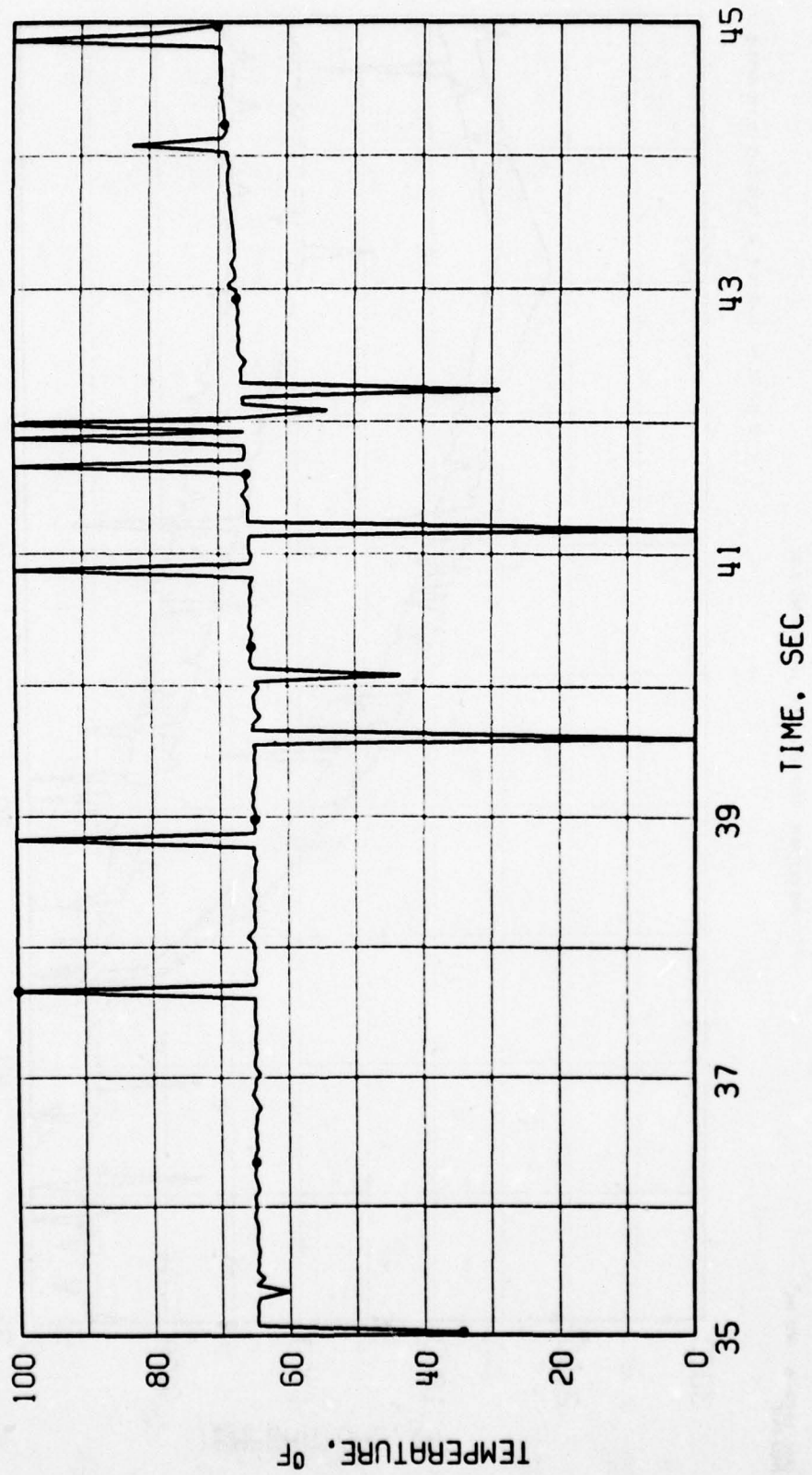
X TC-8-11-5 + TC-7-11-5 ▲ TC-6-11-5 ○ TC-5-11-5



DATE 12-03-76 AND TIME
PROJ-PNIE

PROJECT PNIE TEST R0021 DATE 12-01-76 SEL 2103

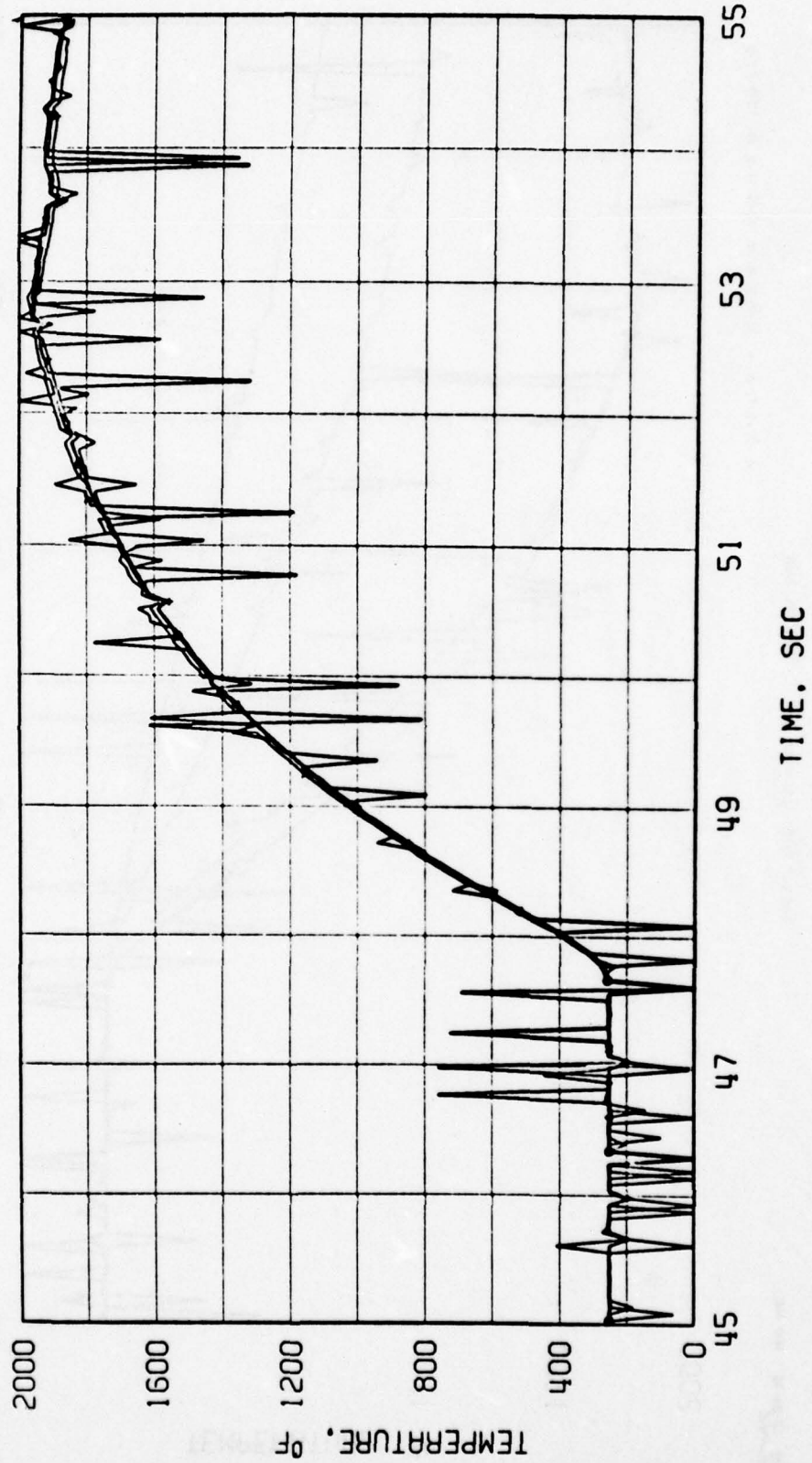
0 TC-9-11-5



DATE 12-03-76 AND INC
PROJ-PNIE

PROJECT PNIE TEST 00021 DATE 12-01-76 SEL 2103

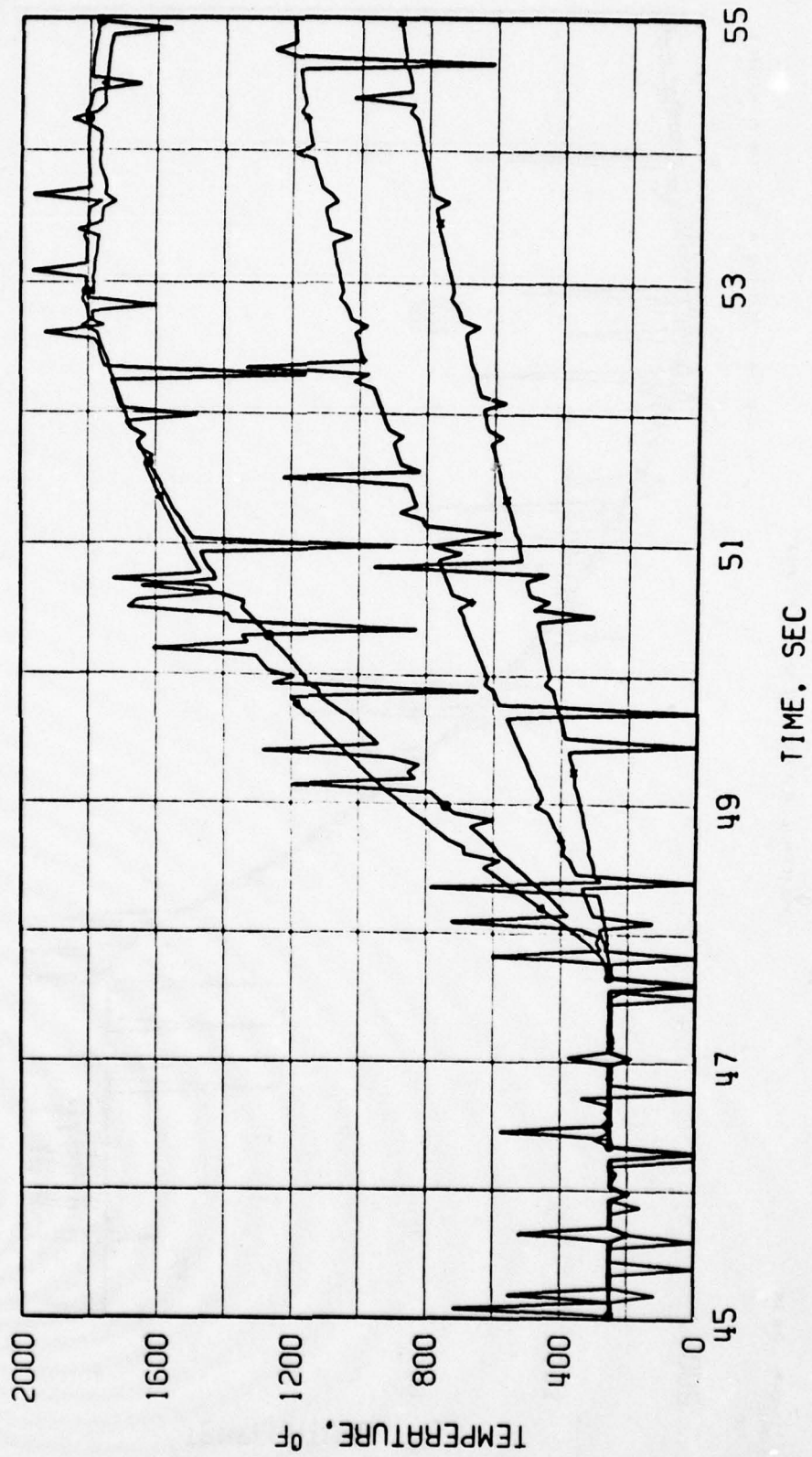
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DATE 12-03-76 AND INC
PROJ-PNIE

PROJECT PNIE TEST 00021 DATE 12-01-76 SEL 2103

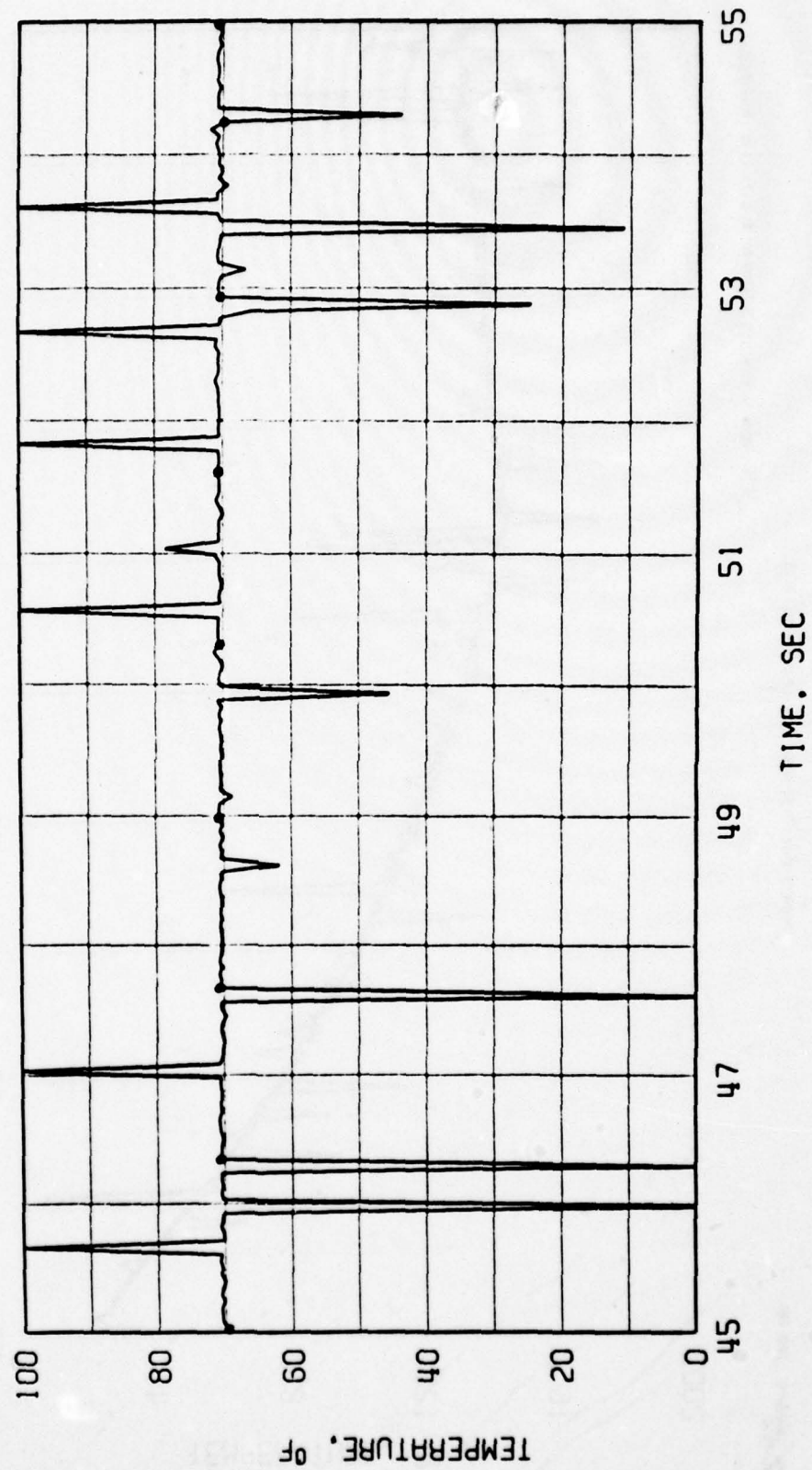
X TC-0-TI-0 + TC-7-TI-0 ▲ TC-6-TI-0 ○ TC-5-TI-0



PROJECT PNIE TEST 00021 DATE 12-01-76 SEL 2100

TC-9-TI-8

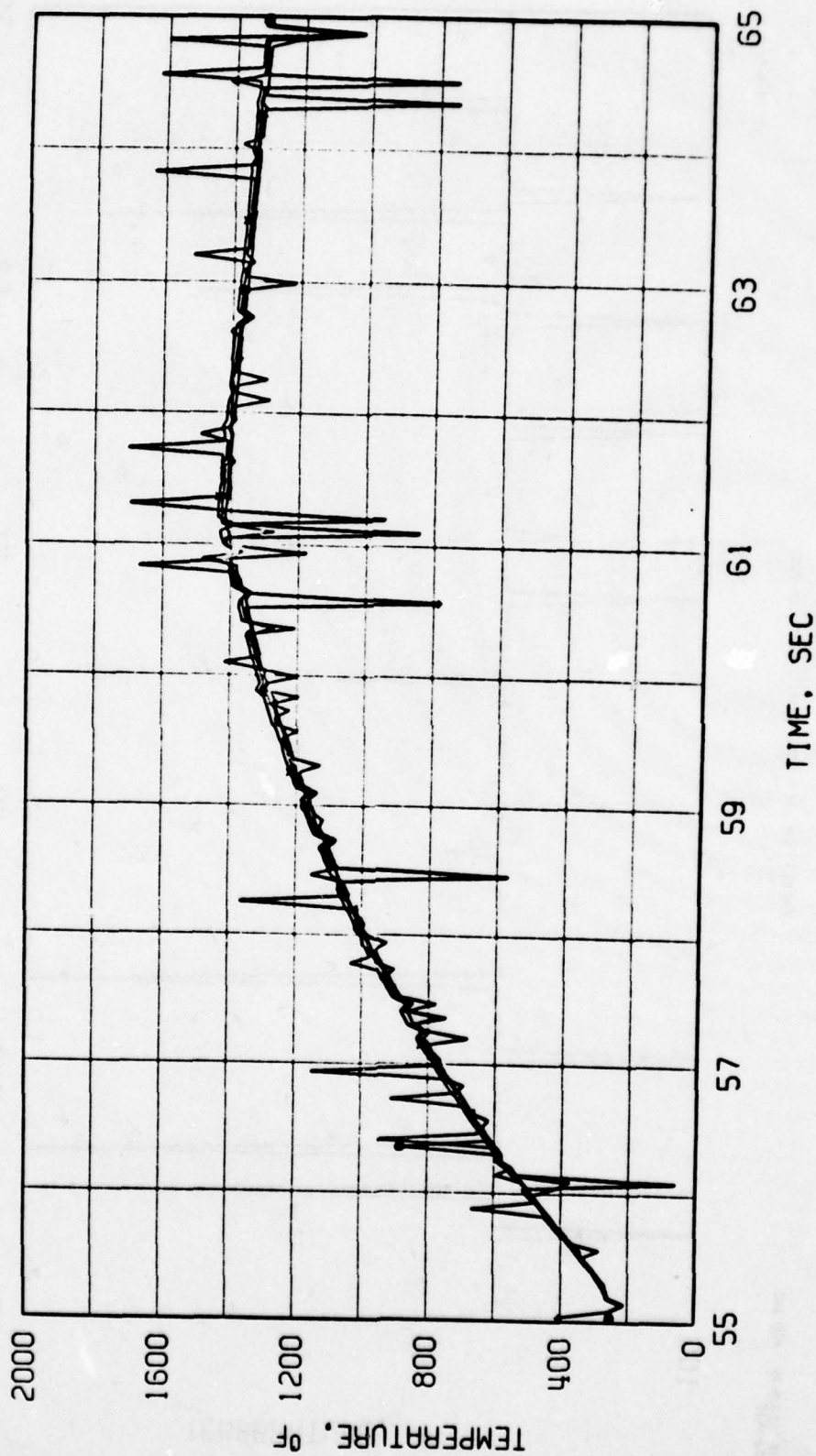
DATE 12-03-76 RND IHC
PROJ-PNIE



DATE 12-03-76 RND INC
PROJ-PILE

PROJECT PILE TEST R0021 DATE 12-01-76 SEL 2109

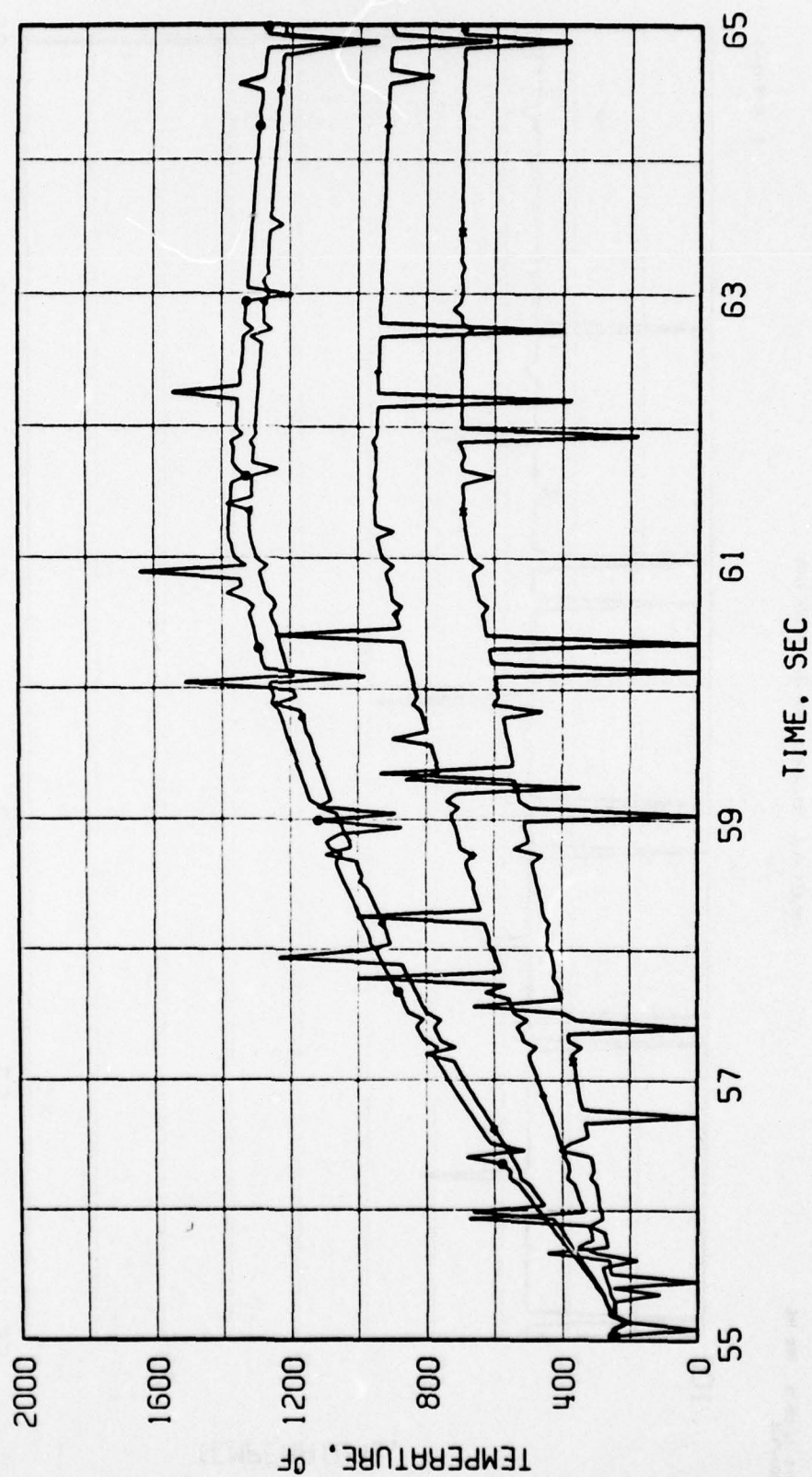
X TC-4-TI-11 + TC-3-TI-11 ▲ TC-2-TI-11 ○ TC-1-TI-11



DATE 12-03-76 GND INC
PROJ-PNIE

PROJECT PNIE TEST 00021 DATE 12-01-76 SEL 2103

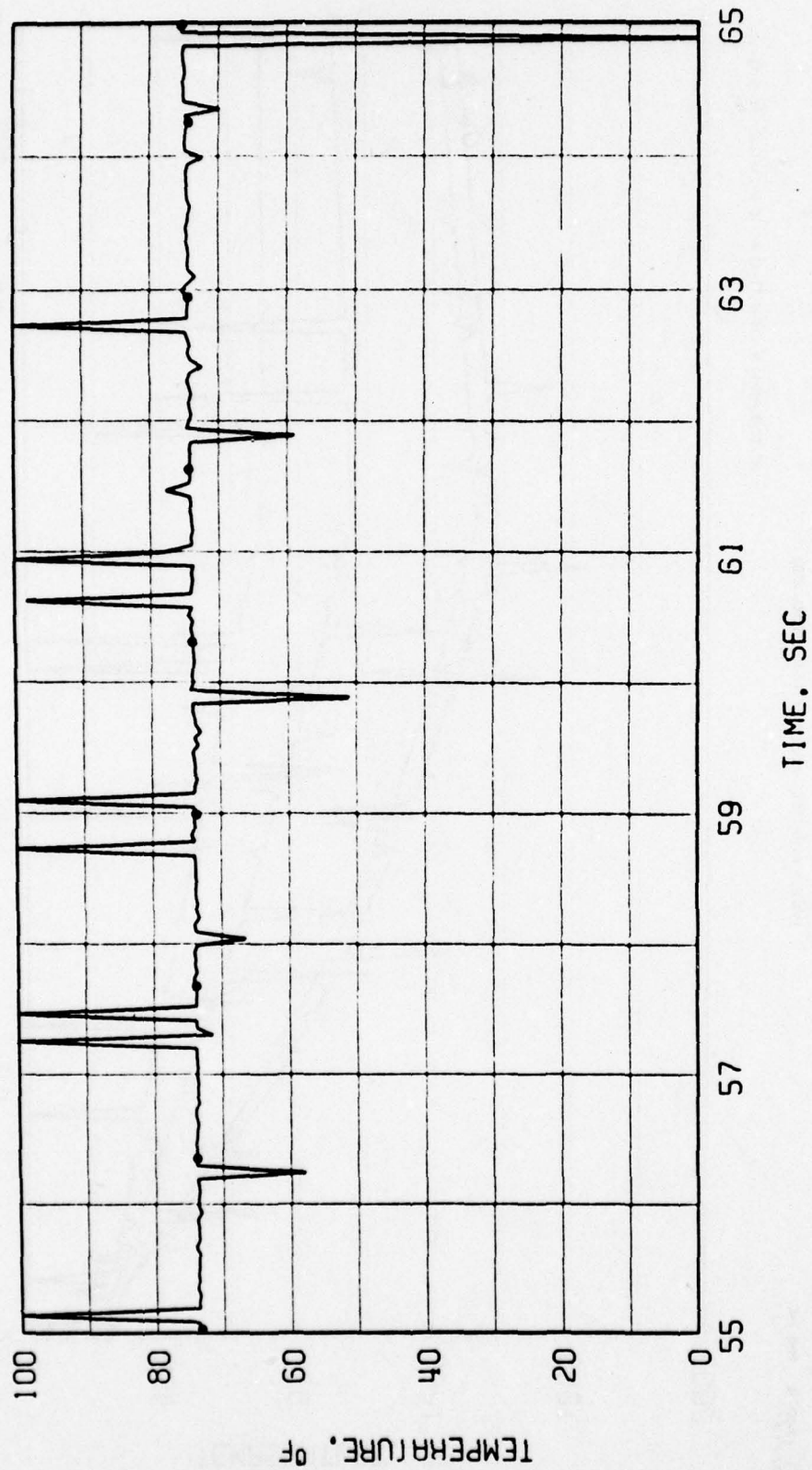
X TC-0-TI-11 + TC-7-TI-11 Δ TC-6-TI-11 ○ TC-5-TI-11



DATE 12-03-78 AND INC
PROJ-PNIE

PROJECT PNIE TEST R0021 DATE 12-01-78 SEL 2103

© TC-9-11-11



DATE 12-03-76 0900 HRC
PROJECT PNIE

TEST R0021 DATE 12-01-76 SEL 2103

▲ EVENT ○ EVENT

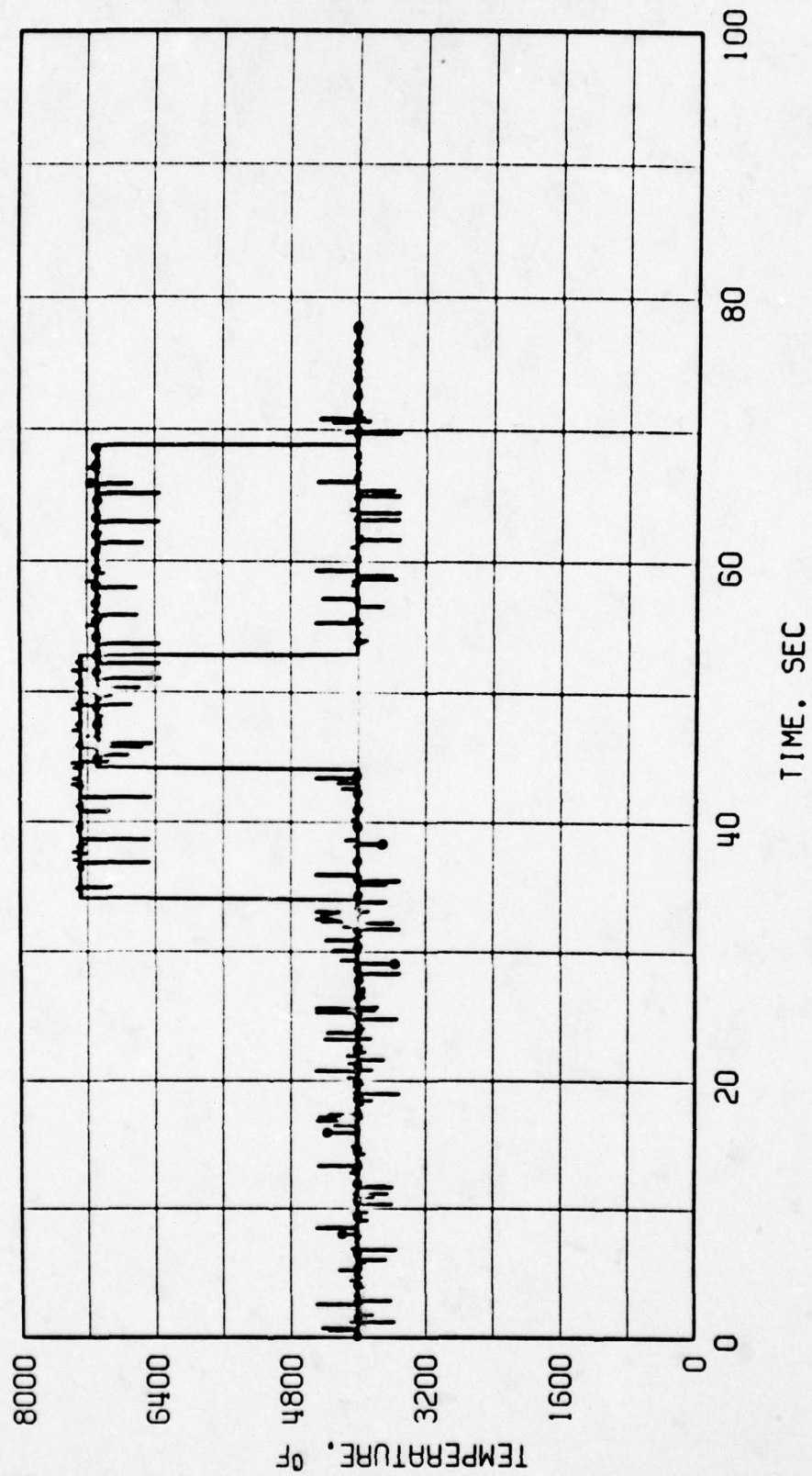


TABLE 1 RUN SUMMARY

RUN 4 DATE 12-3-76

NOZZLE STATION 127.5

TUNNEL CONDITIONS

$P_0 = 506$ psia, $P_{0m} = 475$

$H_{0g} = 487$ 8tu/lbm, $H_{0m} = 286$

$H_0 = 550$ 8tu/lbm

$T_{0g} = 1940$ °R, $T_0 = 2162$ °R

$M = 7.4$ $P_0' = 5.3$ psia

DUST
TYPE MgO
SIZE 100 μ m
VEL 4130 ft/sec
Flow 10.37 gm/sec
C.F. 33.9

WATER
Flow 2.49 gpm
C.F. 302
Orifice 0.062 in.
 ΔP 452 psi

S I N G	MODEL NUMBER	EXPOSURE TIME				MODEL DESCRIPTION			MODEL INSTRUMENTATION				PHOTOGRAPHS			
		PH	DUST	H ₂ O	DUST & H ₂ O	POH	GEOMETRY	DIAM, in.	MATERIAL	T/C TYPE	NO. OF T/C's	PR. TAP	NO. OF TAPS	TRANS- DUCER TYPE	PRERUN	POSTRUN
1	Po' Probe	4					See Fig. 3	1.0	SS			x	1	Strain Gage		
2	To Probe	25					See Fig. 3	0.25		R	1					
3	T _i -7	10.15					Hemi	2.0	6A1-4V- T _i	S	8				7924	
4	WB9-2		4				See Fig. 2	0.5	A1							8035
5	T _i -10		10				Hemi	2.0	6A1-4V- T _i	S	8					8032
6	WB-6R		4	4	x 4		See Fig. 2	2.0	A1							8033
7	T _i -16		8.90	10.51	x 8.90		Hemi	2.0	6A1-4V- T _i	S	8				6837	8034
8	T _i -2			9.76			Hemi	2.0	6A1-4V- T _i	S	8				7733	8031
9	WB9-1			6			See Fig. 2	2.0	A1							8035
10																

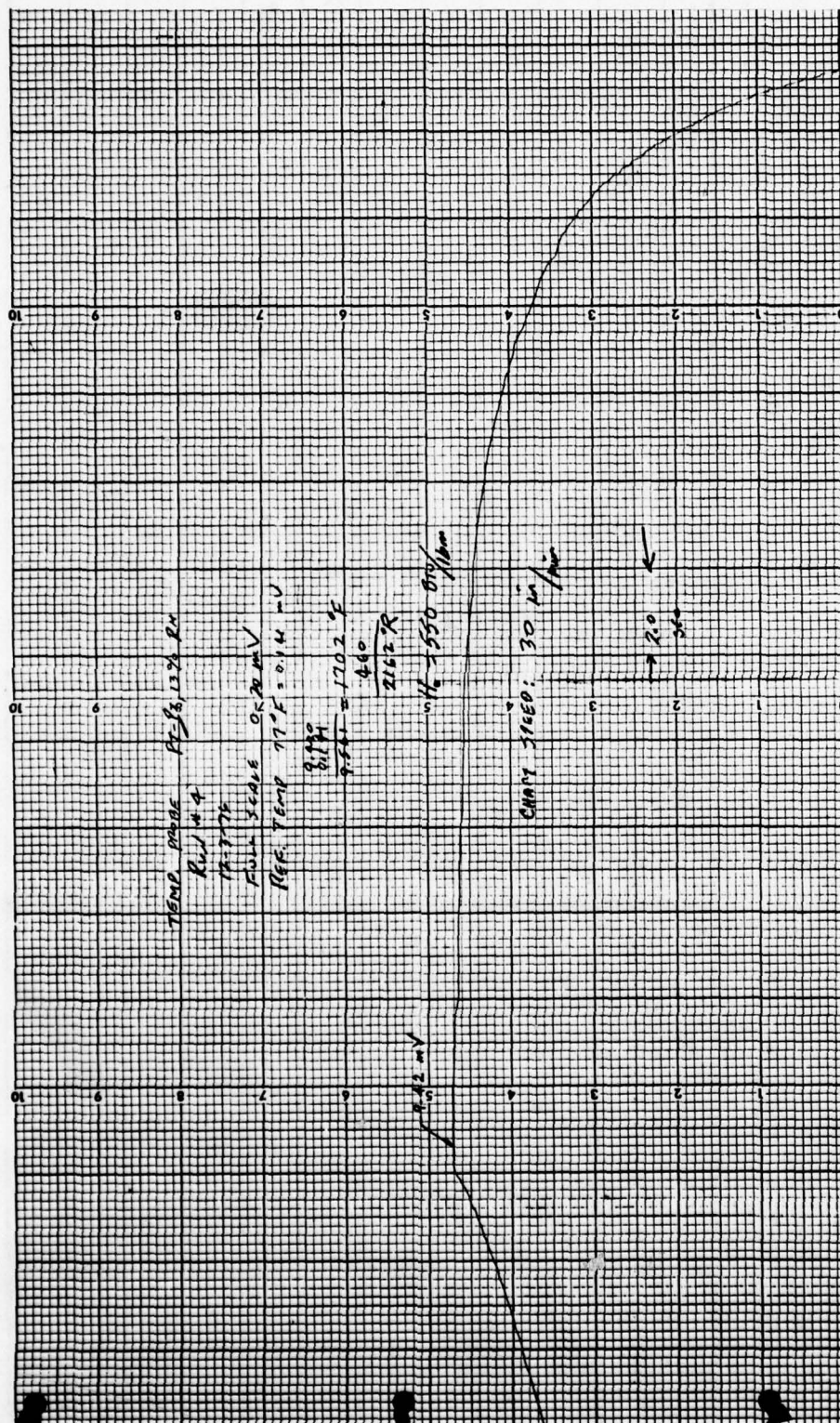
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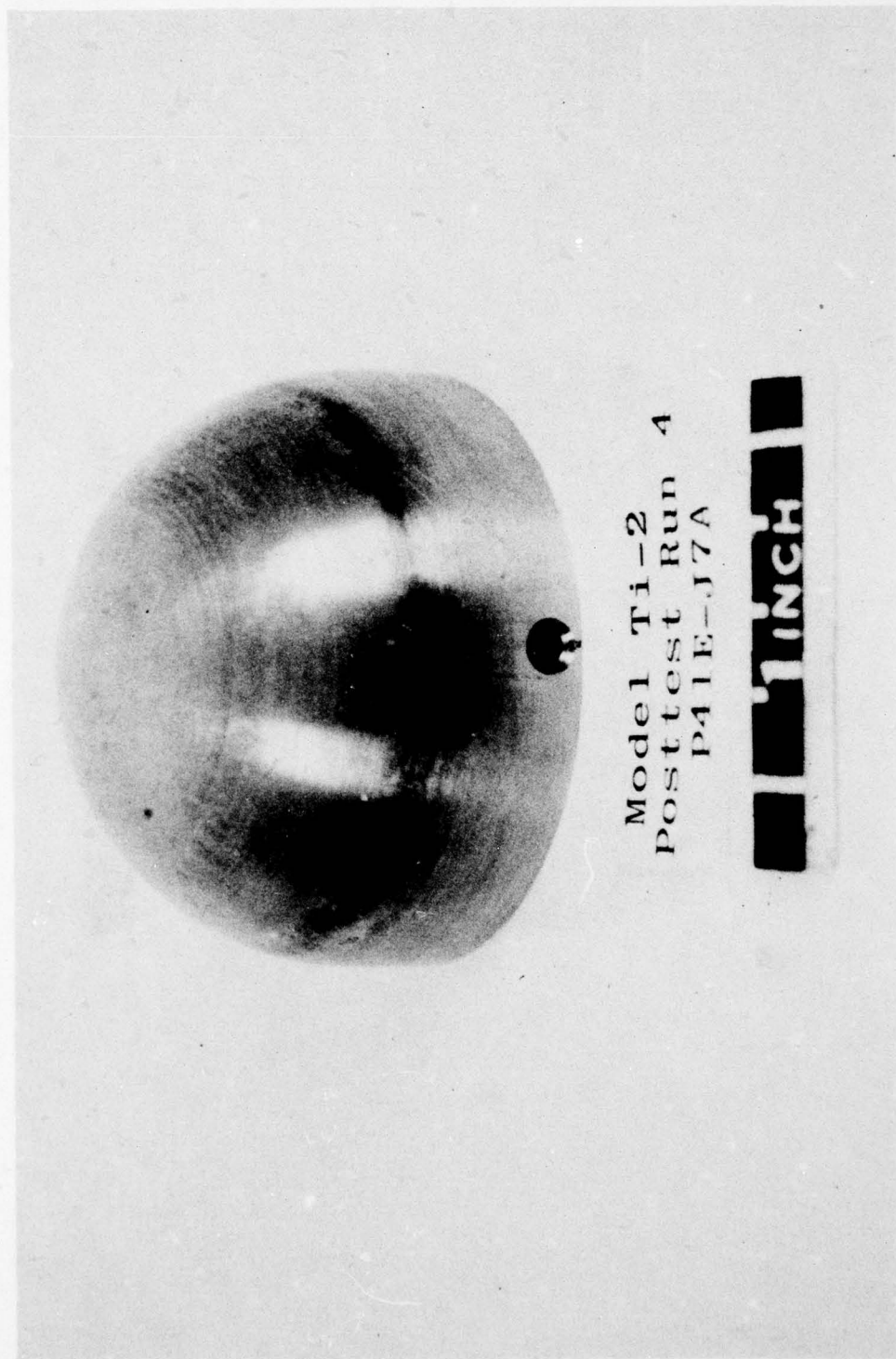
KEY -

PH - PREHEAT

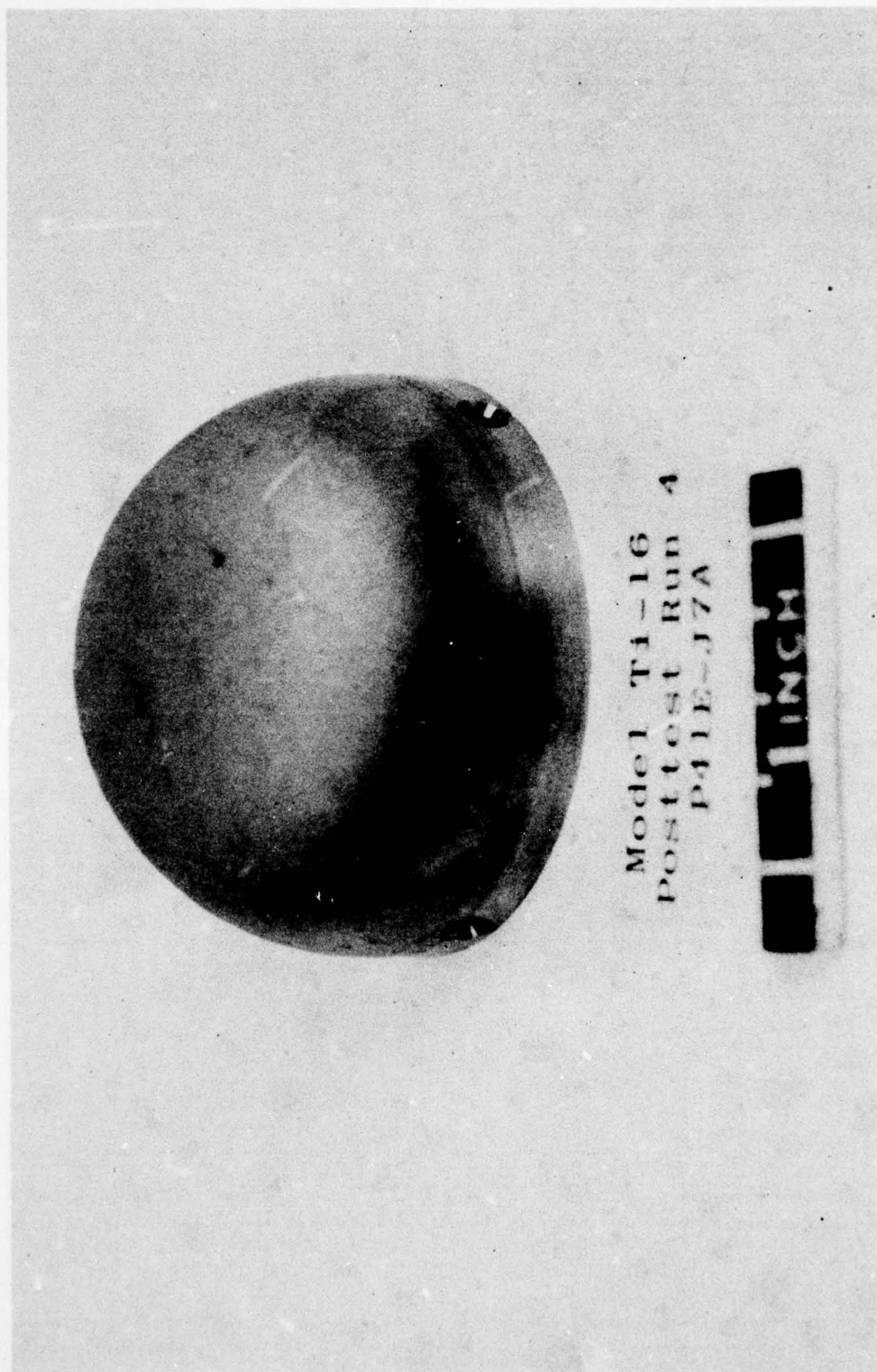
POH - POSTHEAT

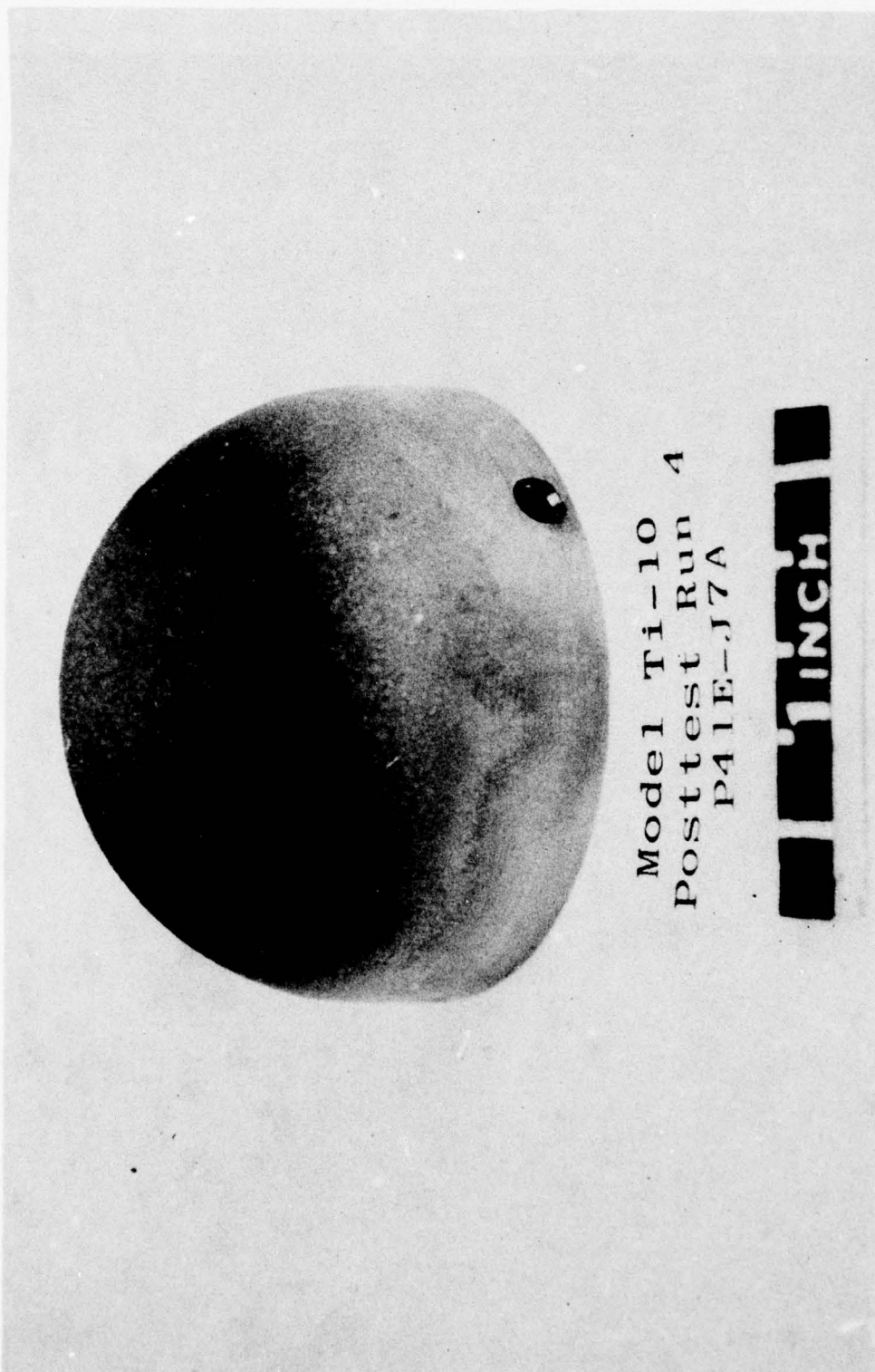
DUST AND H₂O - IF CHECKED, MEANS DUST AND WATER FLOWING AT SAME TIME






Model Ti-2
Post test Run 4
P41E-J7A





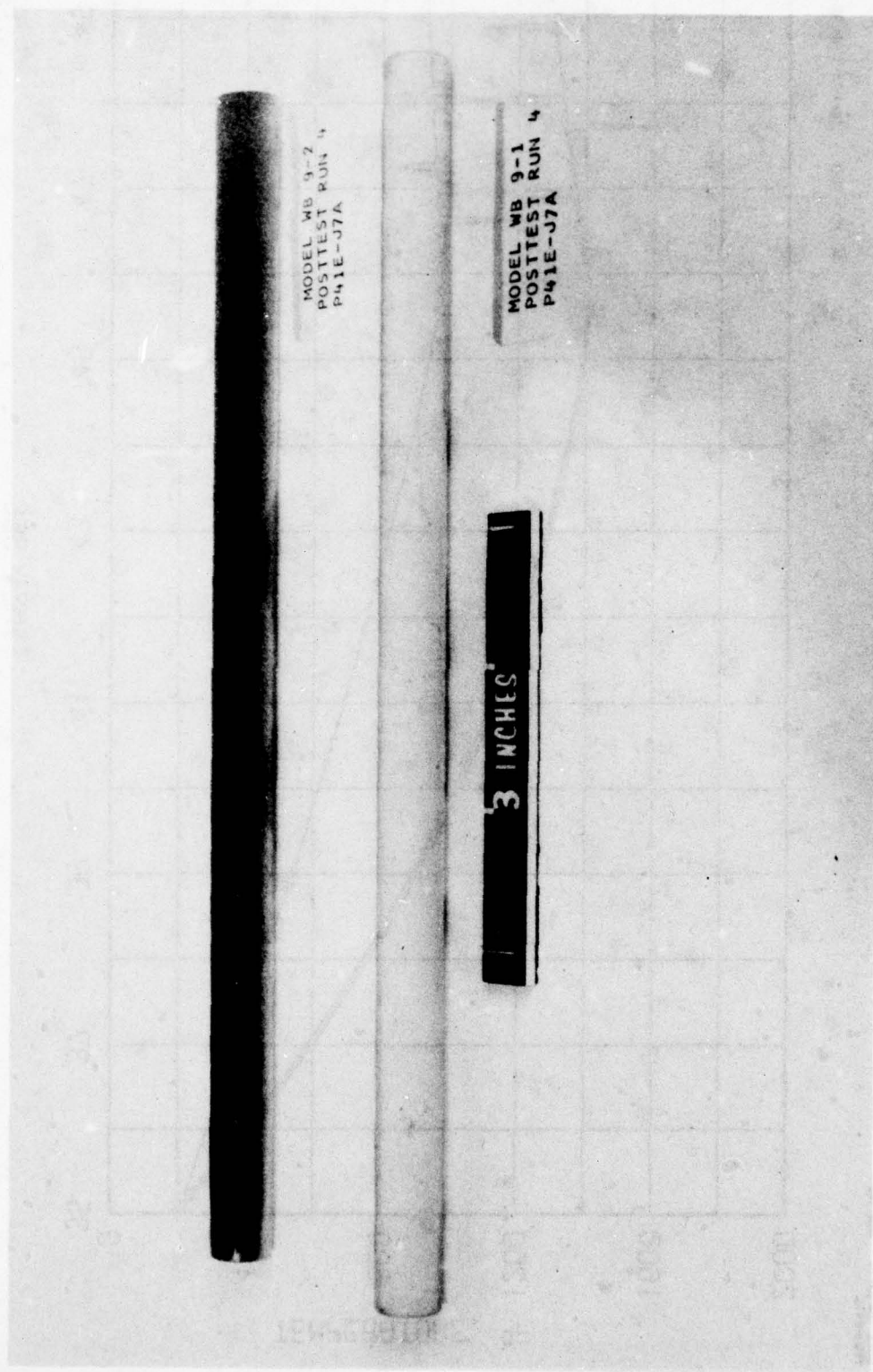
Model Ti-10
Posttest Run 4
P41E-J7A

1 INCH



Model WB-6R 4
Posttest Run
P41E-J7A

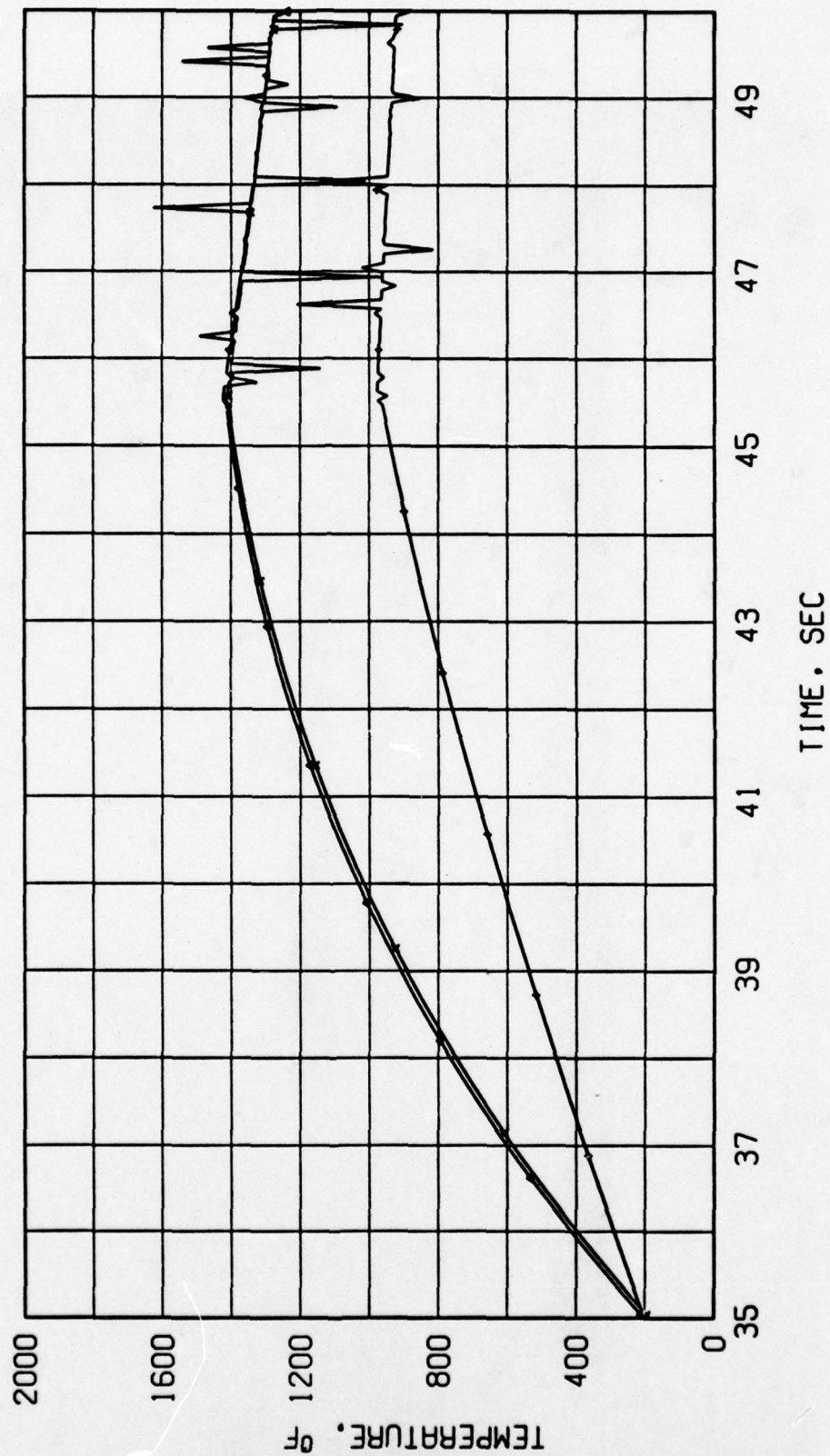




DATE 03-07-77 ASD INC
PROJ-PAIL

PROJECT P4IL TEST R0021 DATE 12-03-76 SEL 2104

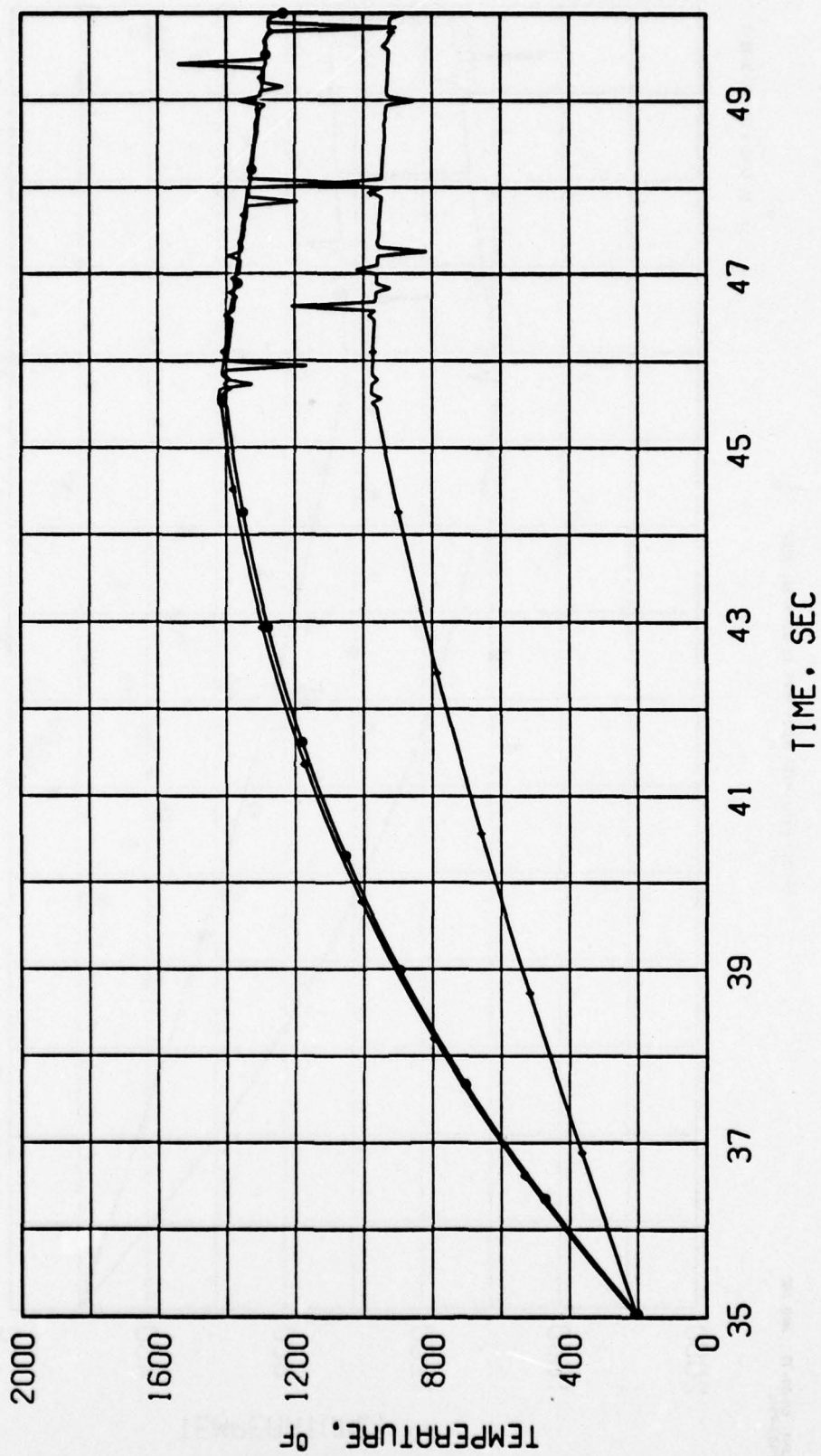
x TC-7-11-7 + TC-4-11-7 ▲ TC-1-11-7



DATE 03-07-77 AND INC
PROJ-P41L

PROJECT P41L TEST R0021 DATE 12-03-76 SEL 2104

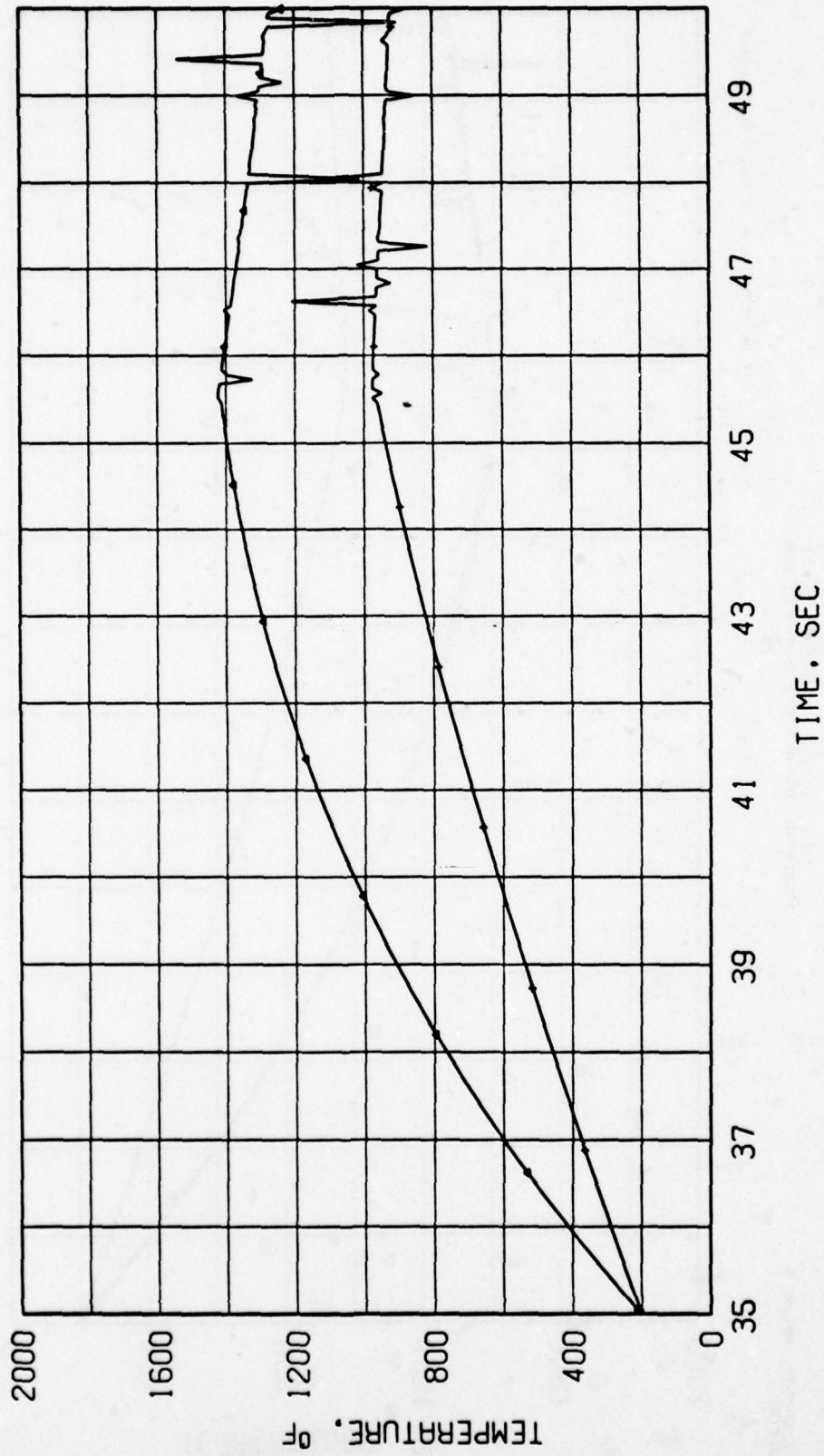
♦ TC-8-11-7 ▲ TC-5-11-7 ○ TC-2-11-7



DATE 03-07-77 RND INC
PROJ-P4IL

PROJECT P4IL TEST R0021 DATE 12-03-76 SEL 2104

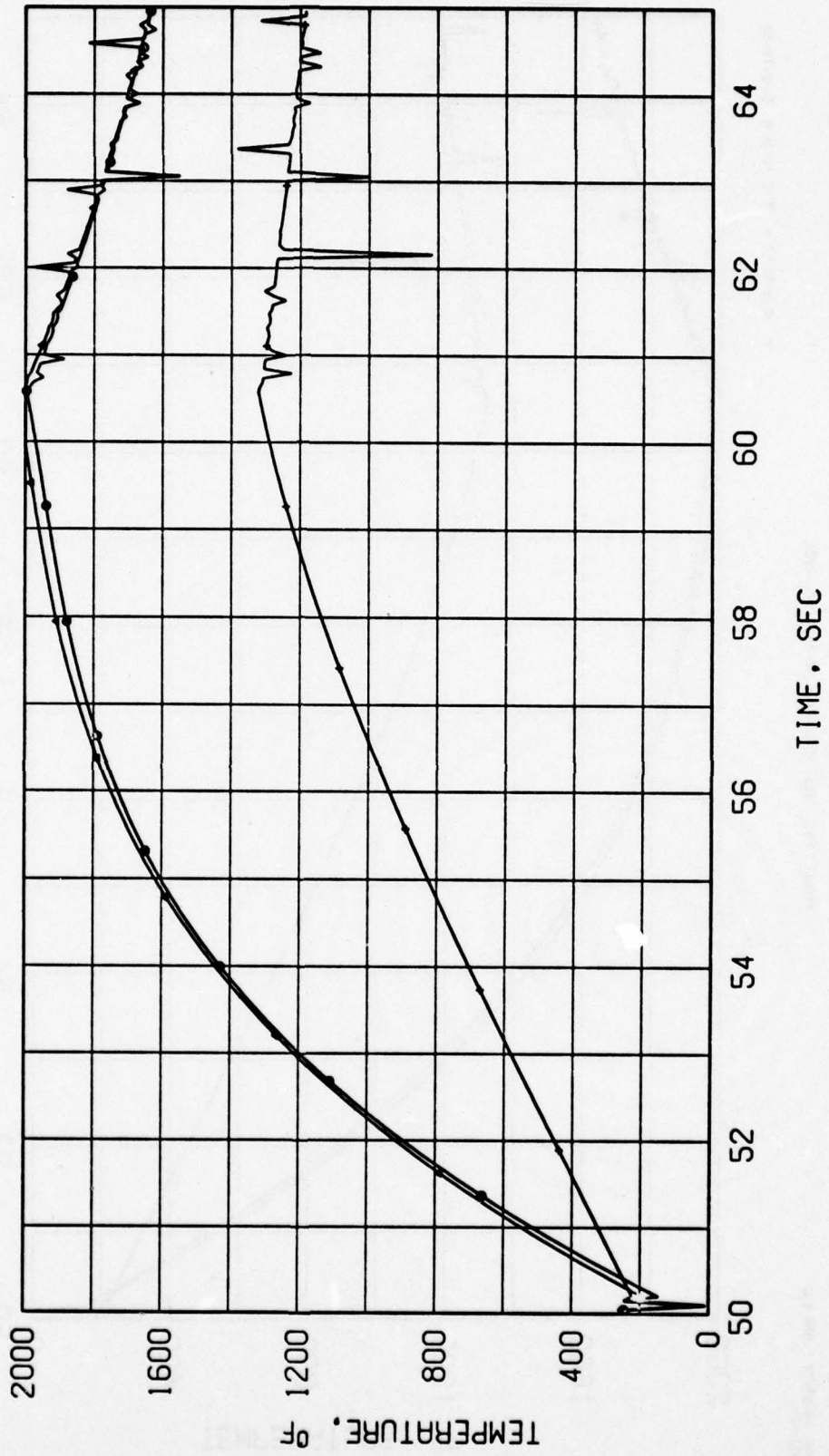
+ TC-6-11-7 ▲ TC-3-11-7



DATE 03-07-77 PRO INC
PROJ-PAIL

PROJECT PAIL TEST 00021 DATE 12-03-76 SEL 2104

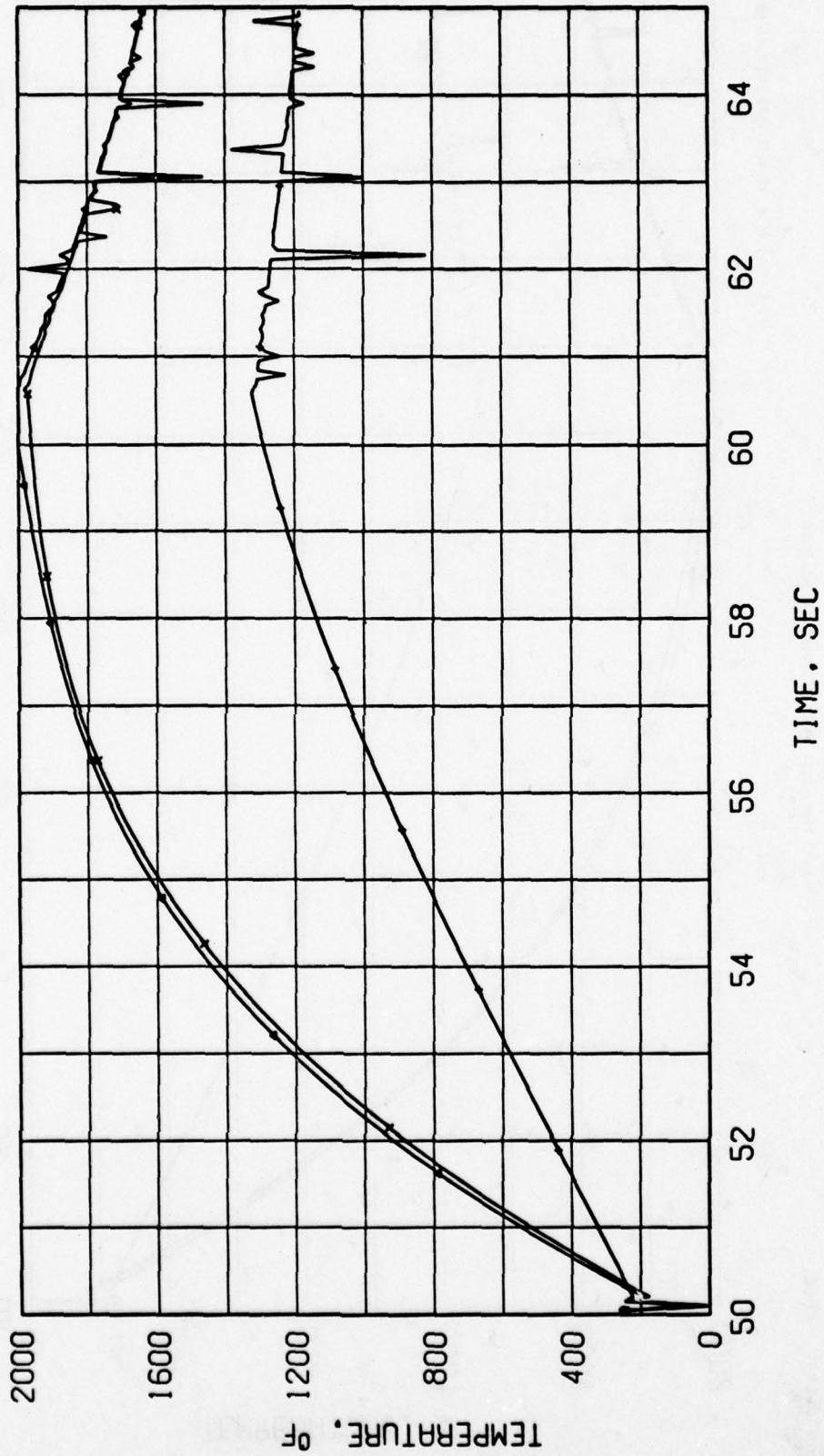
+ TC-7-TI-10 ▲ TC-4-TI-10 ○ TC-1-TI-10



DATE 03-07-77 RMO INC
PROJ-PAIL

PROJECT PAIL TEST R0021 DATE 12-03-76 SEL 2104

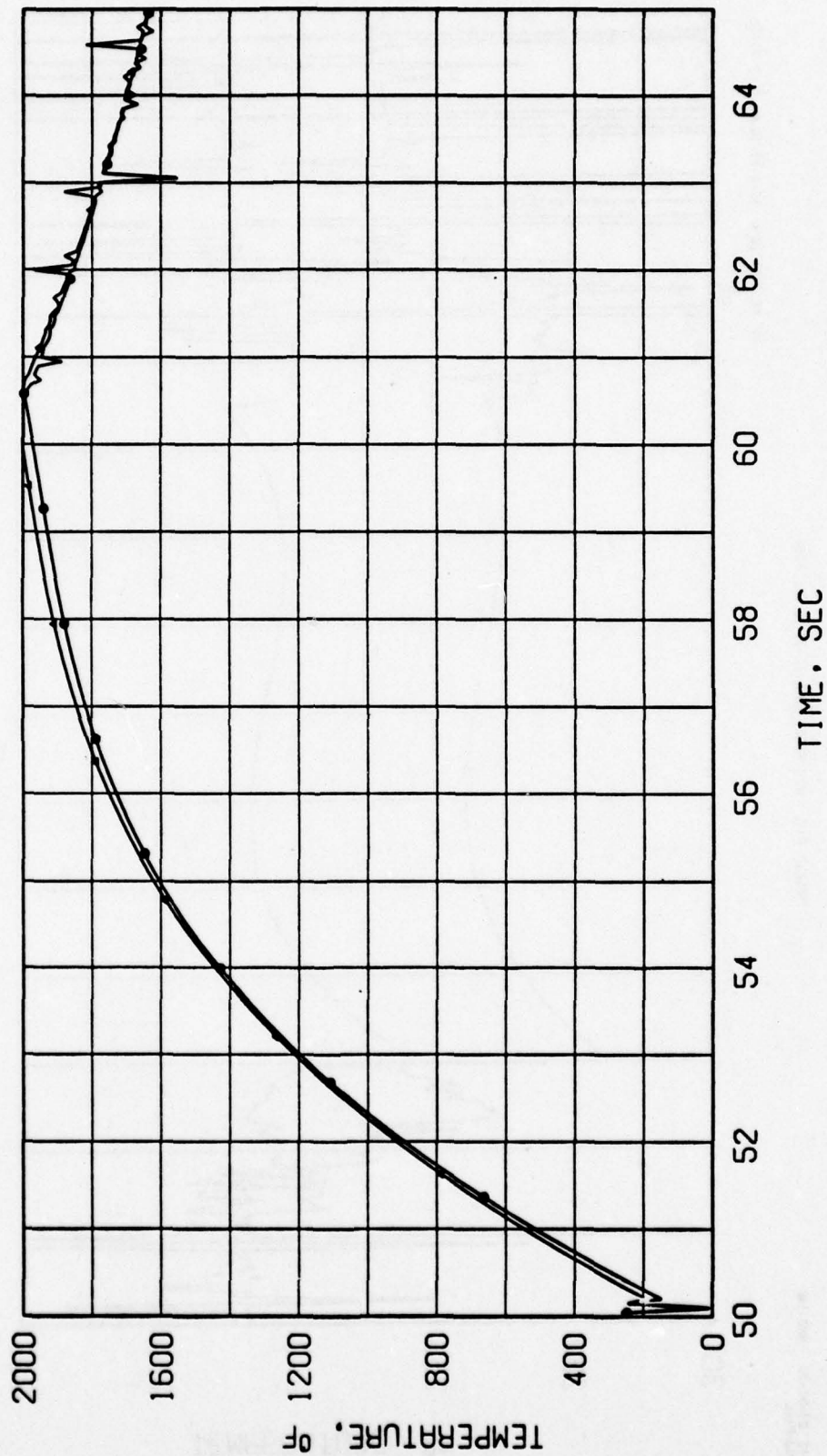
X TC-8-11-10 + TC-5-11-10 ▲ TC-2-11-10



DATE 03-07-77 RND INC
PROJ-P4IL

PROJECT P4IL TEST R0021 DATE 12-03-76 SEL 2104

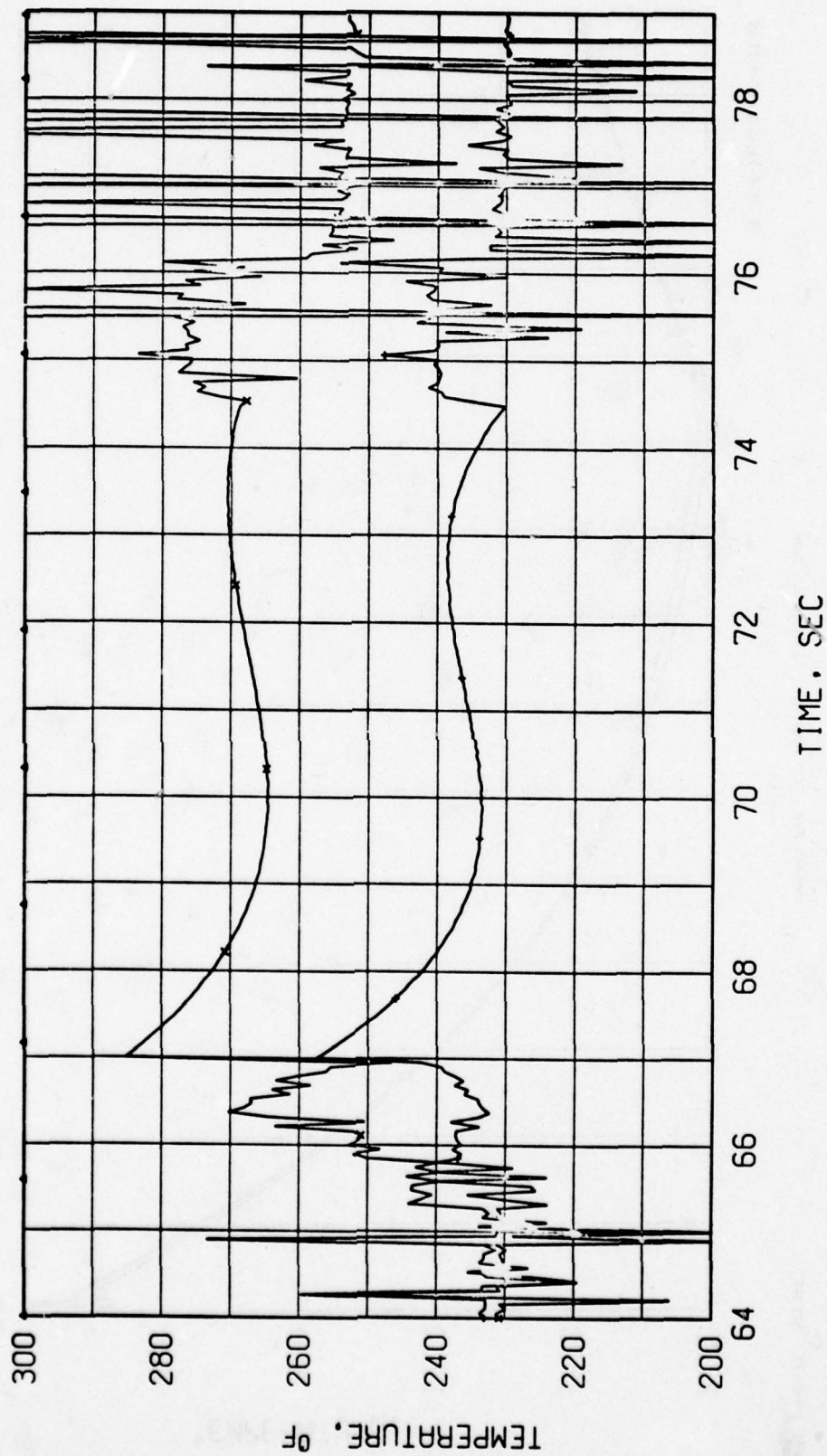
▲ TC-6-T1-10 ○ TC-3-T1-10



DATE 03-07-77 AND INC
PROJ-P4IL

PROJECT P4IL TEST #0021 DATE 12-03-76 SEL 2104

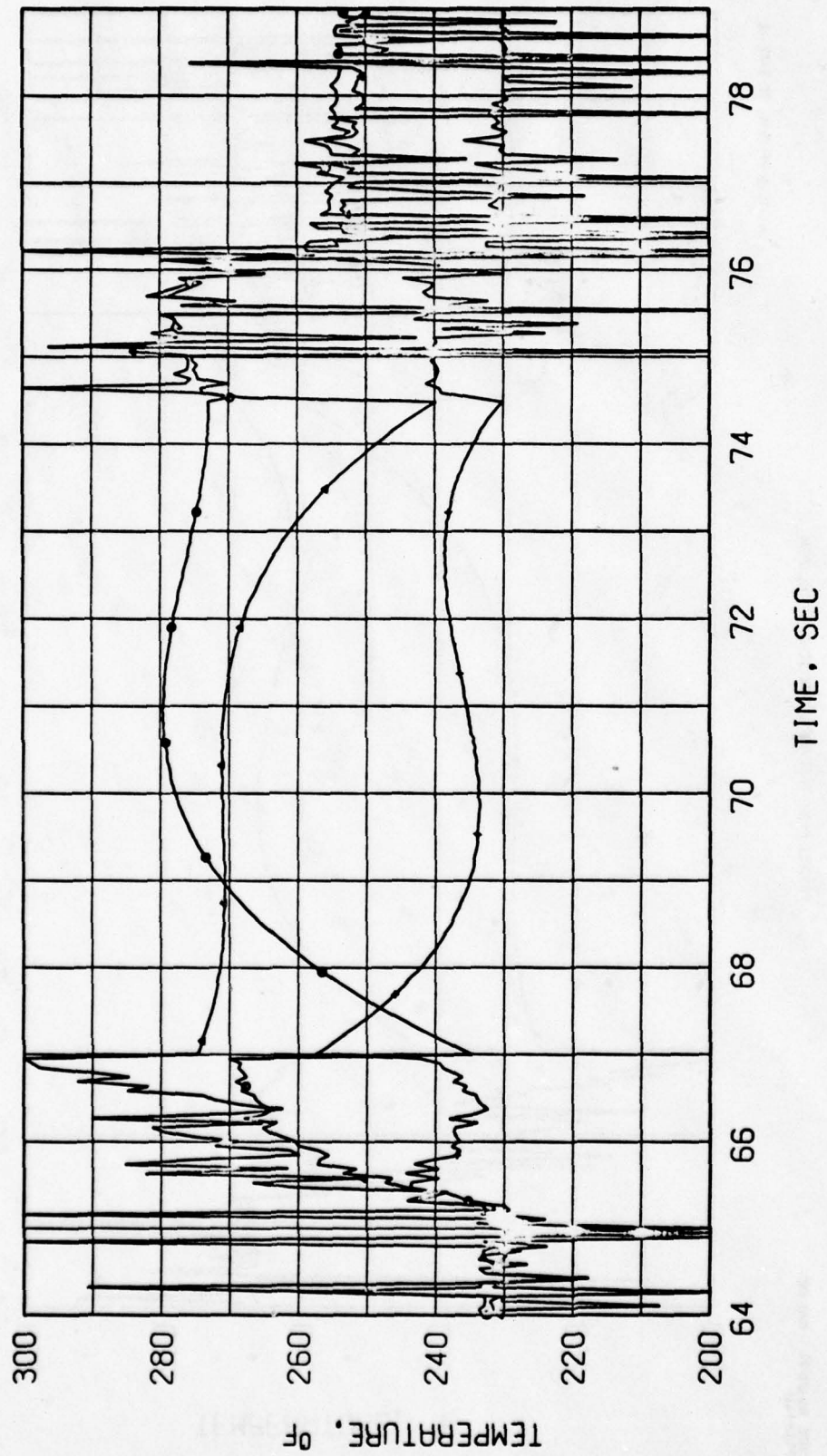
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DATE 03-07-77 AND INC
PROJ-PAIL

PROJECT PAIL TEST R0021 DATE 12-03-76 SEL 2104

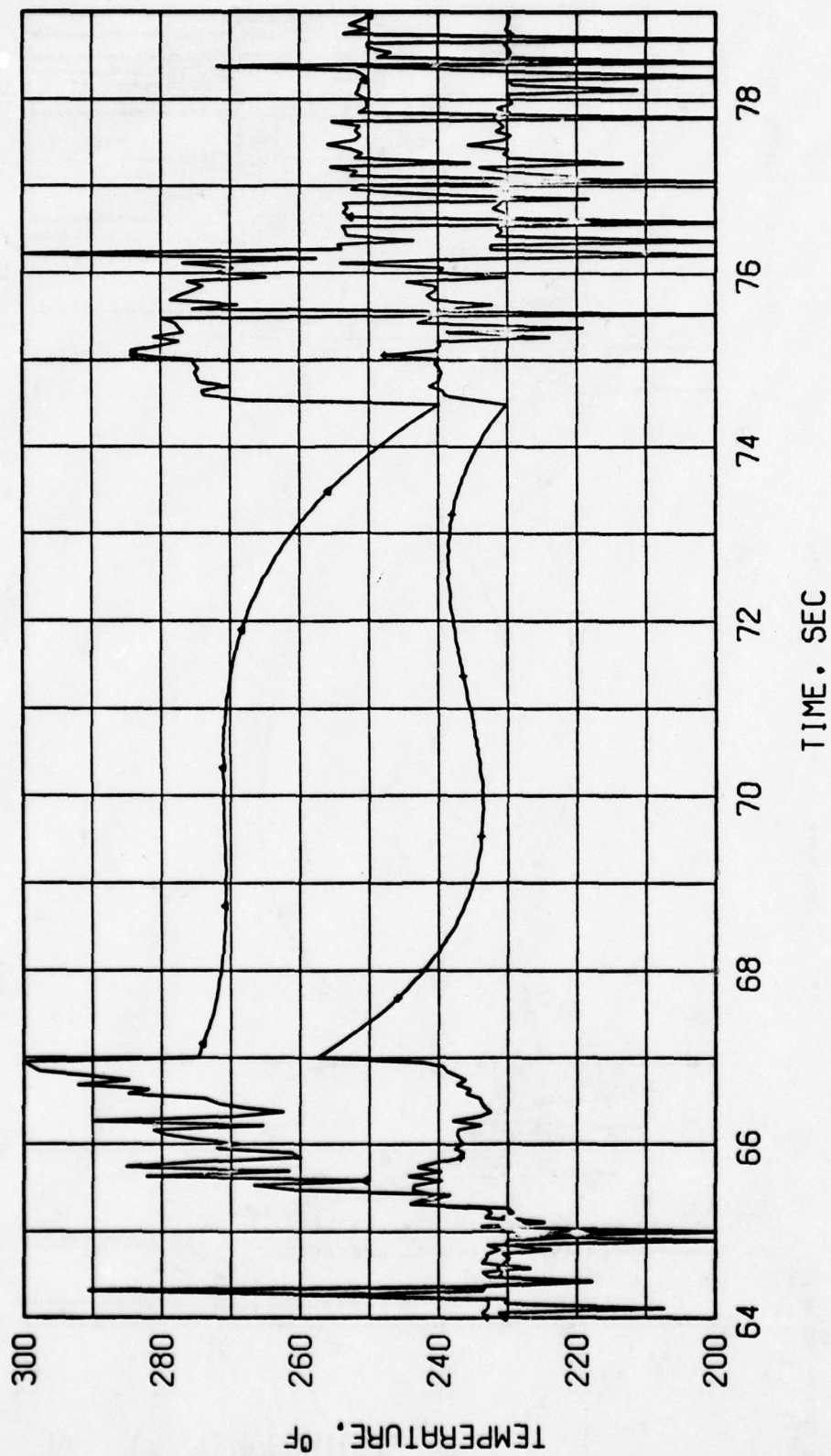
+ TC-8-TI-16 ▲ TC-5-TI-16 ○ TC-2-TI-16



DATE 03-07-77 RND INC
PROJ-PAIL

PROJECT PAIL TEST 00021 DATE 12-03-76 SEL 2104

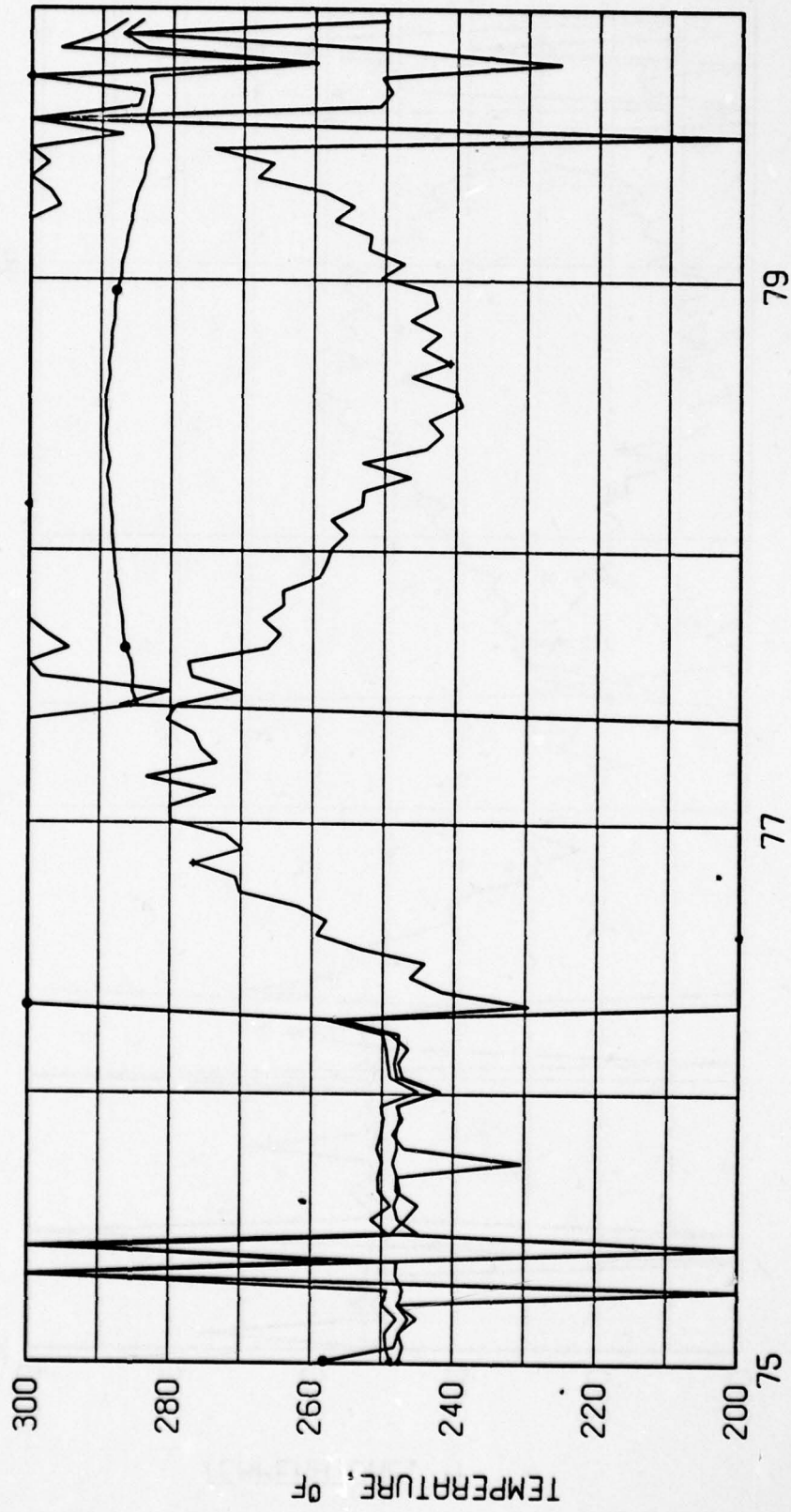
+ TC-6-11-16 Δ TC-3-11-16



DATE 03-07-77 680 INC
PROJ-P4IL

PROJECT P4IL TEST R0021 DATE 12-03-76 SEL 2104

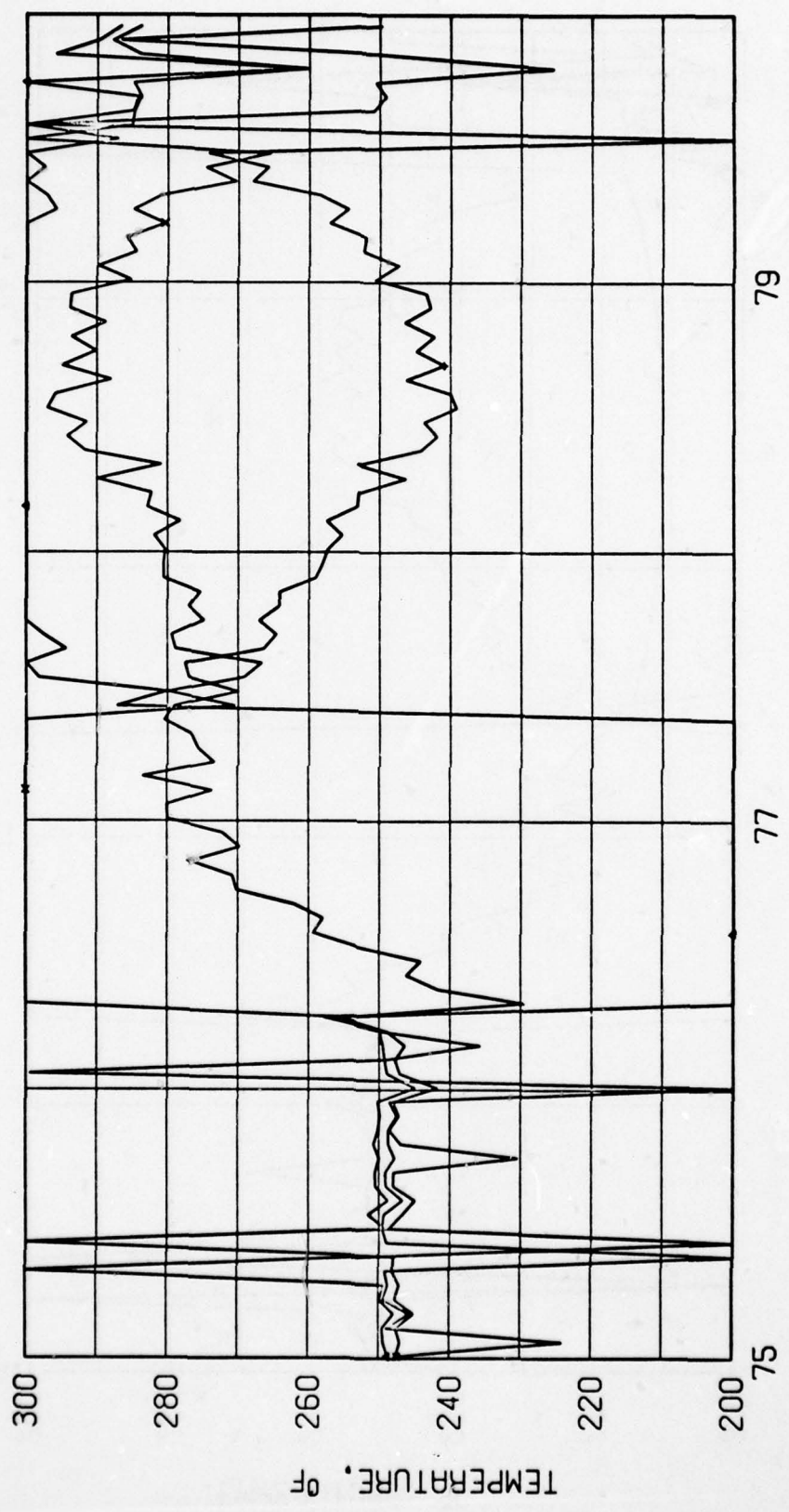
+ IC-7-II-2 ▲ IC-4-II-2 ○ IC-1-II-2



DATE 03-07-77 PRO INC
PROJ-PAIL

PROJECT PAIL TEST R0021 DATE 12-03-76 SEL 2104

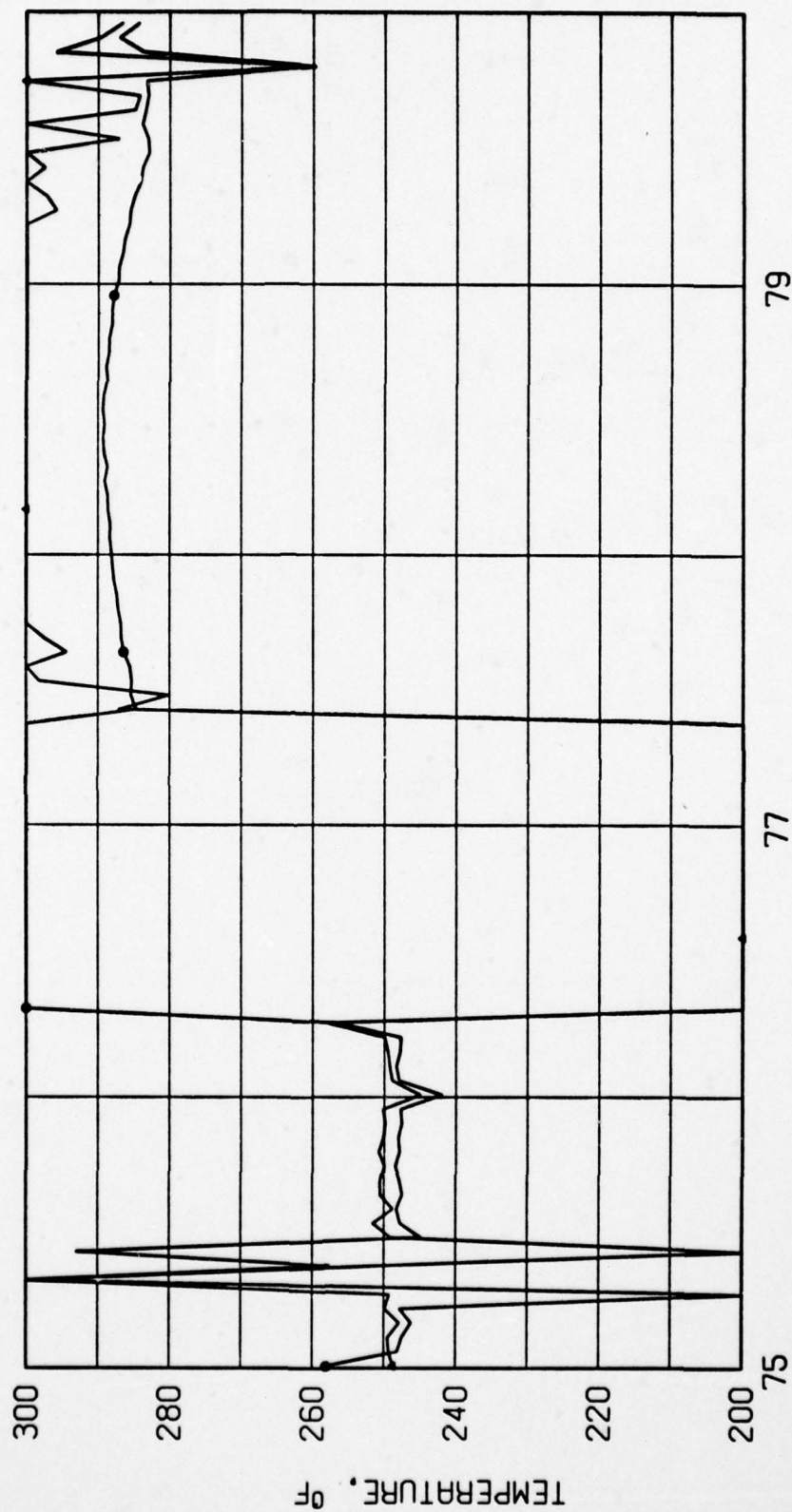
X TC-8-TI-2 + TC-5-TI-2 ▲ TC-2-TI-2



DATE 03-07-77 RMO INC
PROJ-P41L

PROJECT P41L TEST R0021 DATE 12-03-76 SEL 2104

▲ IC-6-11-2 ○ IC-3-11-2



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TABLE 1 RUN SUMMARY

RUN 5 DATE 1-6-77

TUNNEL CONDITIONS

Po = 500 psia, Pom = 499

Hog = 496 Btu/lbm, Hom = 476

uo = 515 Btu/lbm

Tog = 1960 °R, To = 2028 °R

y = 7.5 po' = 5.3 psia

DUST
MgO
TYPE
SIZE 100 μm
VEL 4050 ft/sec
Flow 10.89 gm/sec
C.F. 26.6

WATER
0.228 gpm
28.2 C.F.
0.020 in.
894 psi
ΔP

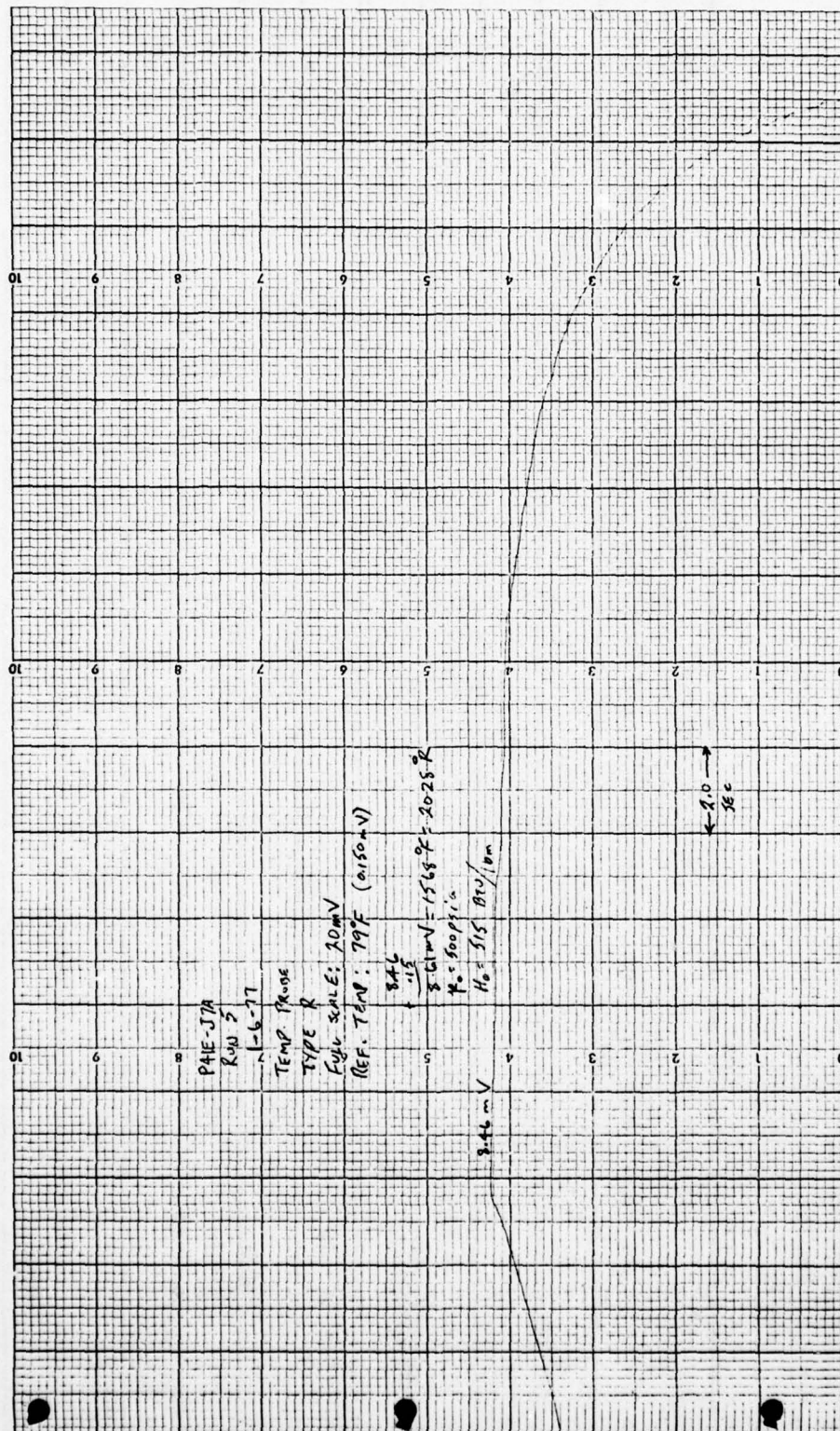
S I N G	MODEL NUMBER	EXPOSURE TIME				MODEL DESCRIPTION				MODEL INSTRUMENTATION				PHOTOGRAPHS		
		PH	DUST	H ₂ O	DUST & H ₂ O	POH	GEOMETRY	DIAM, In.	MATERIAL	T/C TYPE	NO.OF T/C's	PR. TAP	NO.OF TAPS	TRANS- DUCER TYPE	PRERUN	POSTRUN
1	Po probe	3					See Fig. 3	1.0	SS			x	1	Strain Gage		
2	To probe	25					See Fig. 3	0.25		R	1					
3	Ti-12	8.55	1.19				Hemi	2.0	6Al-4V- Ti	S	8				6838	102
4	Ti-14		9.97				Hemi	2.0	6Al-4V- Ti	S	8				6837	103
5	WB-15 WB-1A		10	10	x 10		See Fig. 2		SS Al							99
6	Ti-15		10.28	5.49	x 5.49		Hemi	2.0	6Al-4V- Ti	S	8				6837	100
7	Ti-7	4.47		5.49			Hemi	2.0	6Al-4V- Ti	S	8					101
8	WB-2S WB-2A			10			See Fig. 2		SS Al							98
9	GS			25			See Fig. 4	2.0	SS							
10																

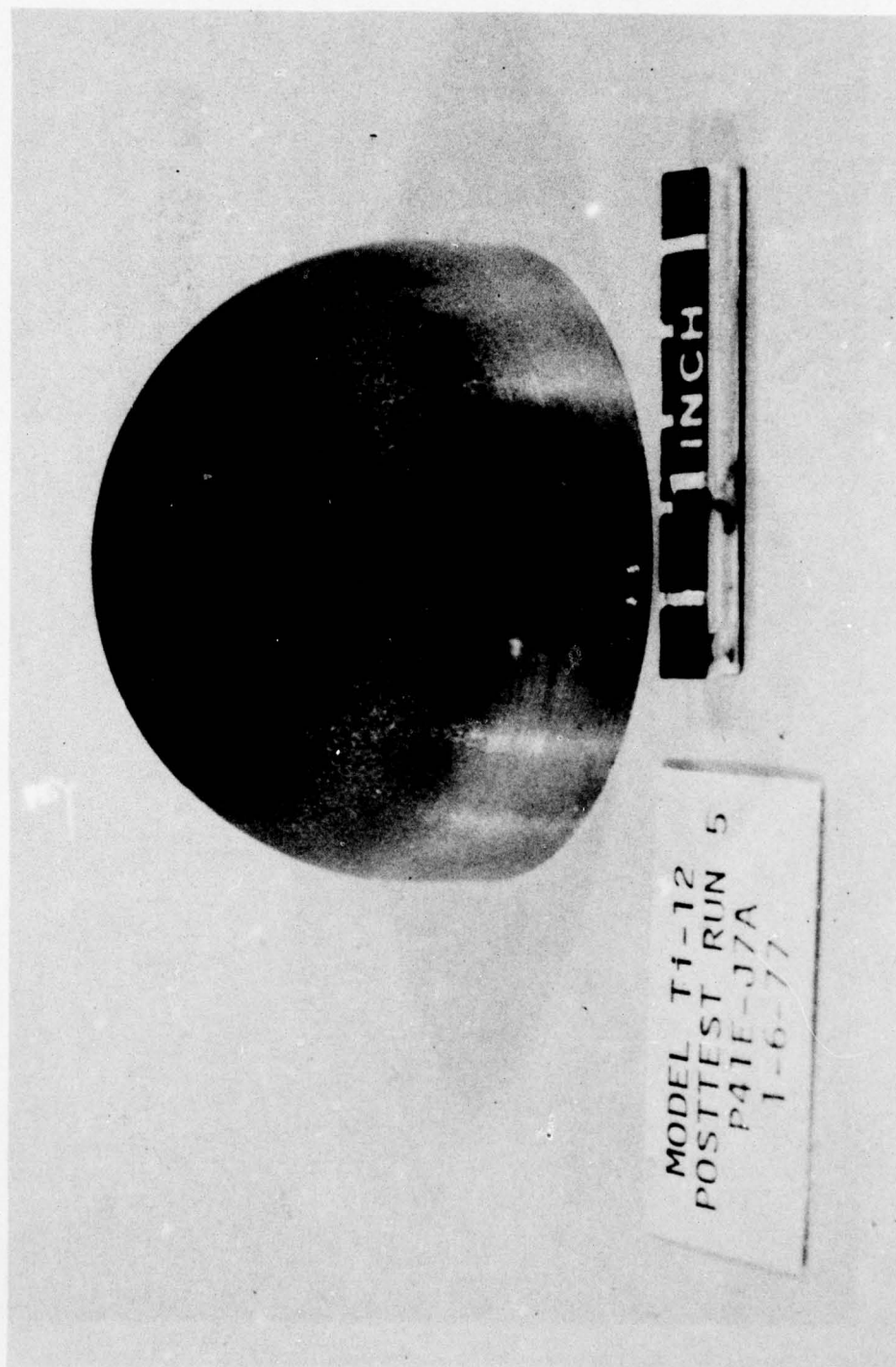
KEY -

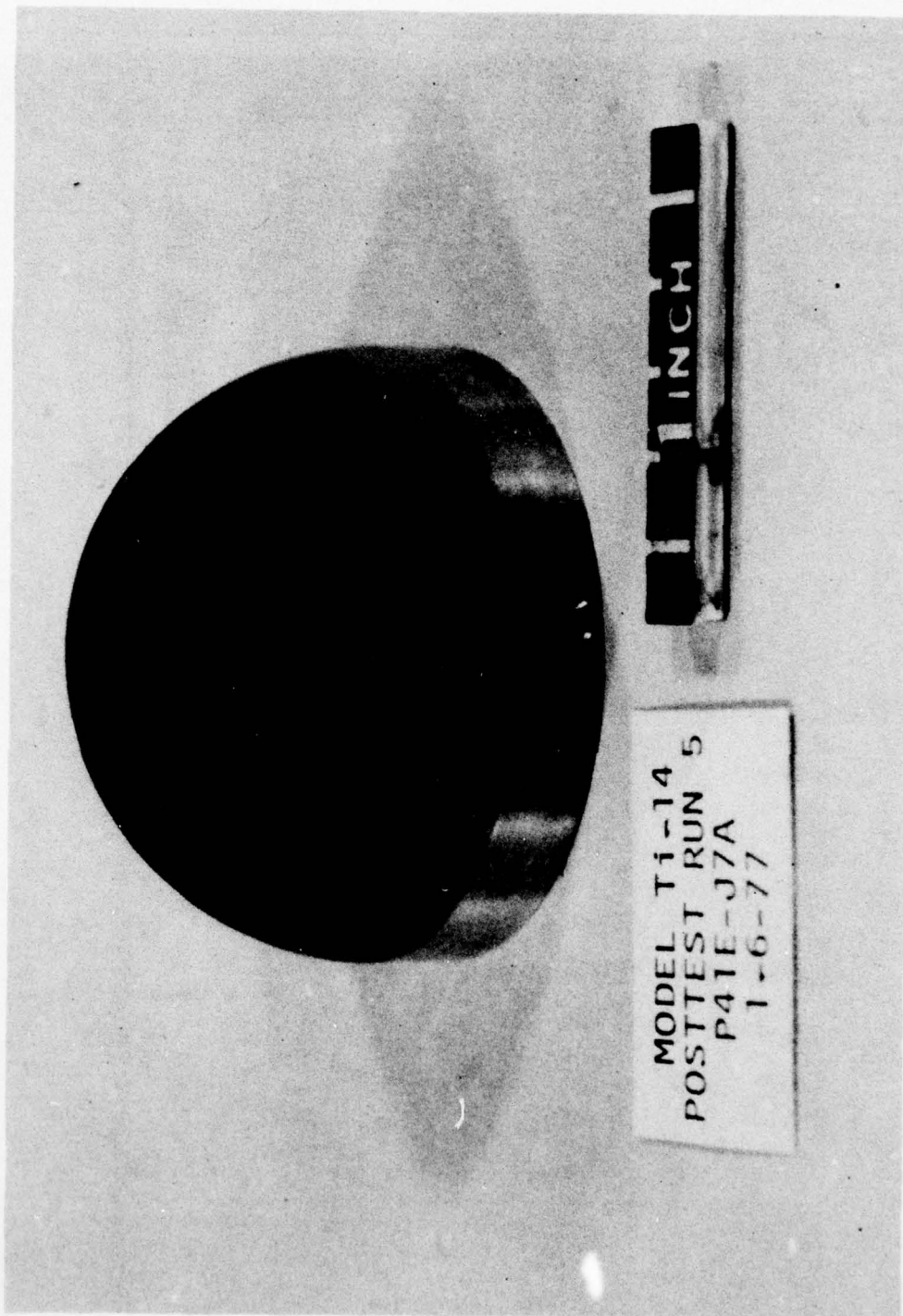
ph - PREHEAT
POH - POSTHEAT
DUST AND H₂O - IF CHECKED, MEANS DUST AND WATER FLOWING AT SAME TIME

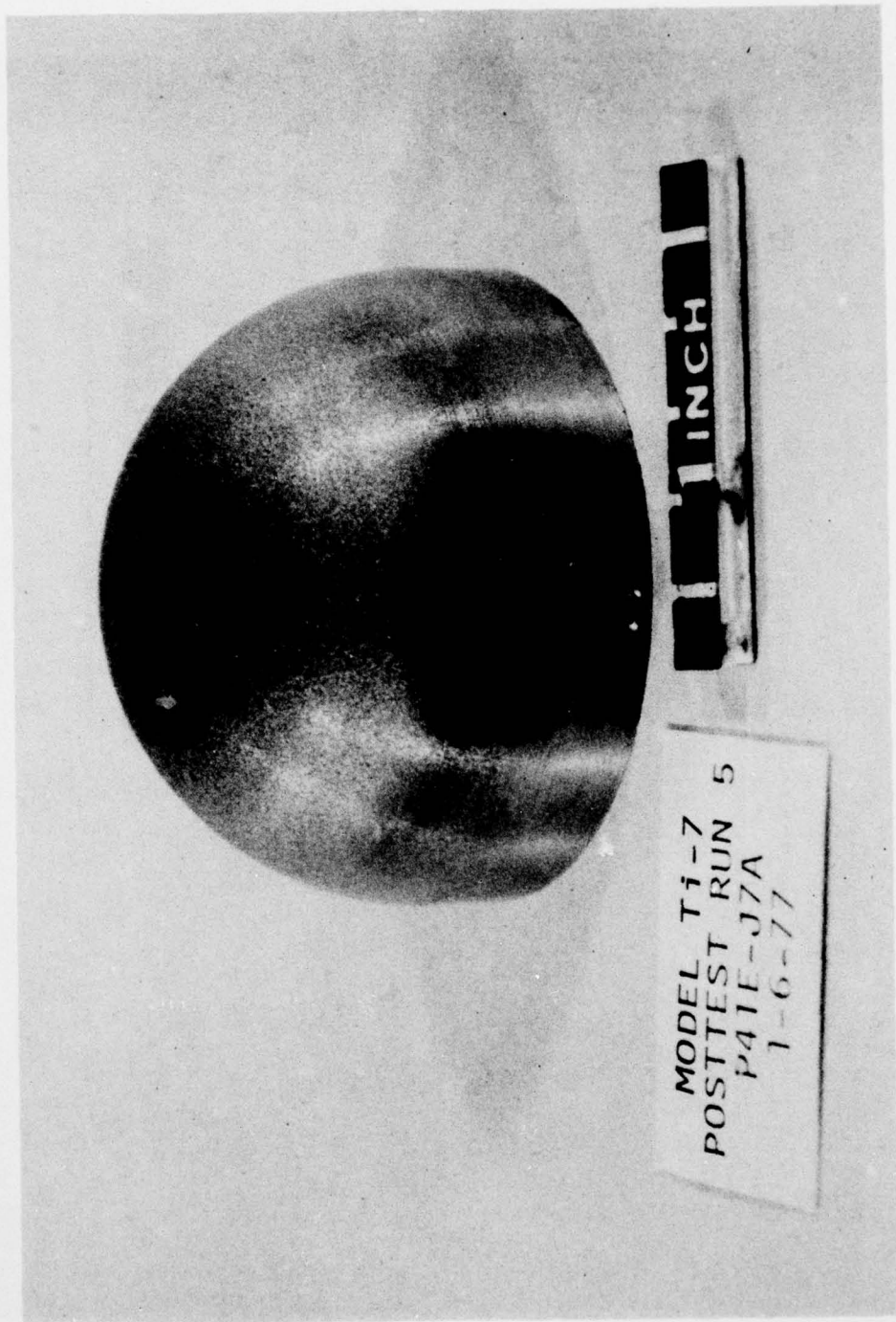
NOTES: 1. Model GS on Sting No. 9 is a
gas sampling model.

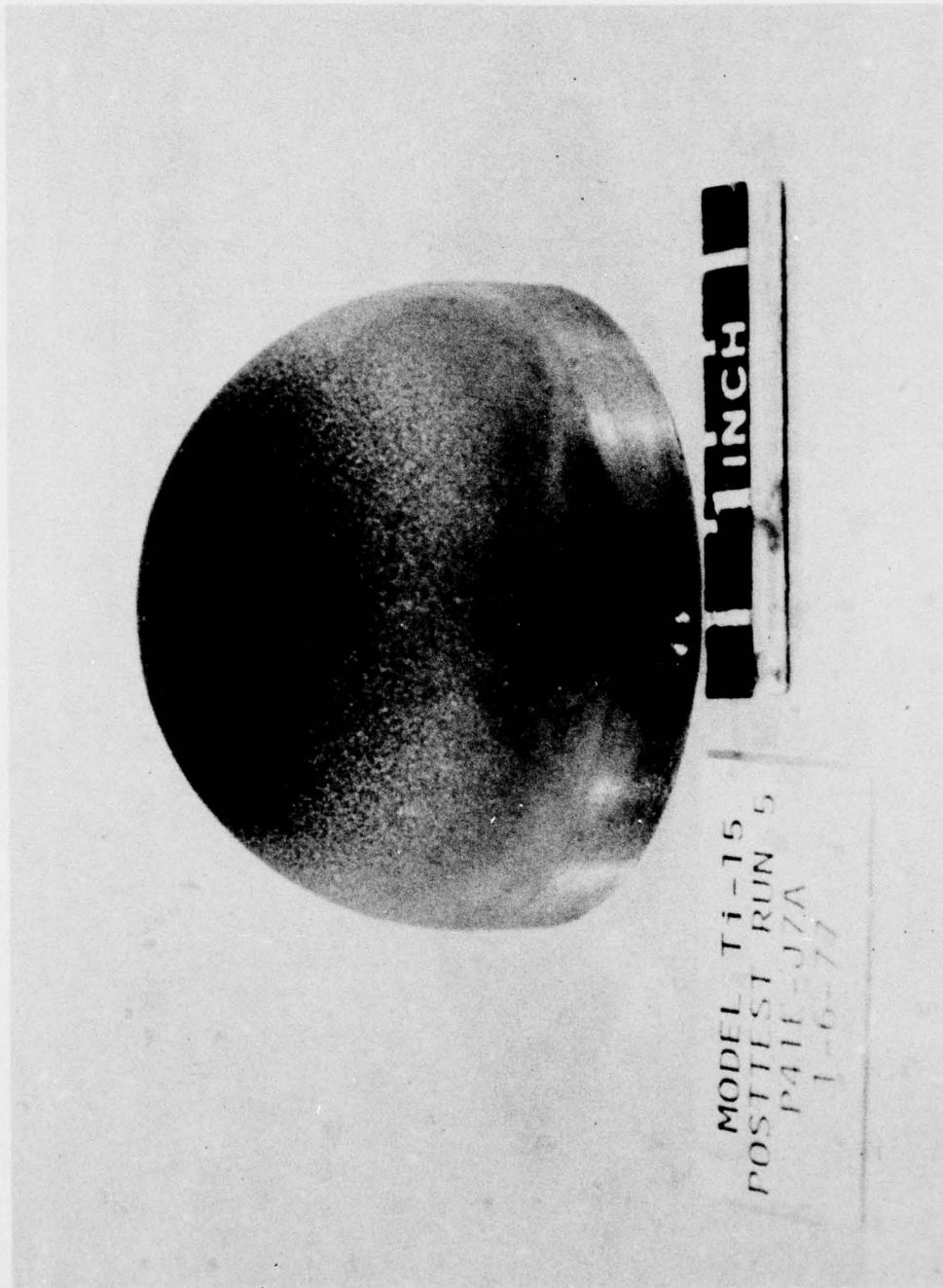
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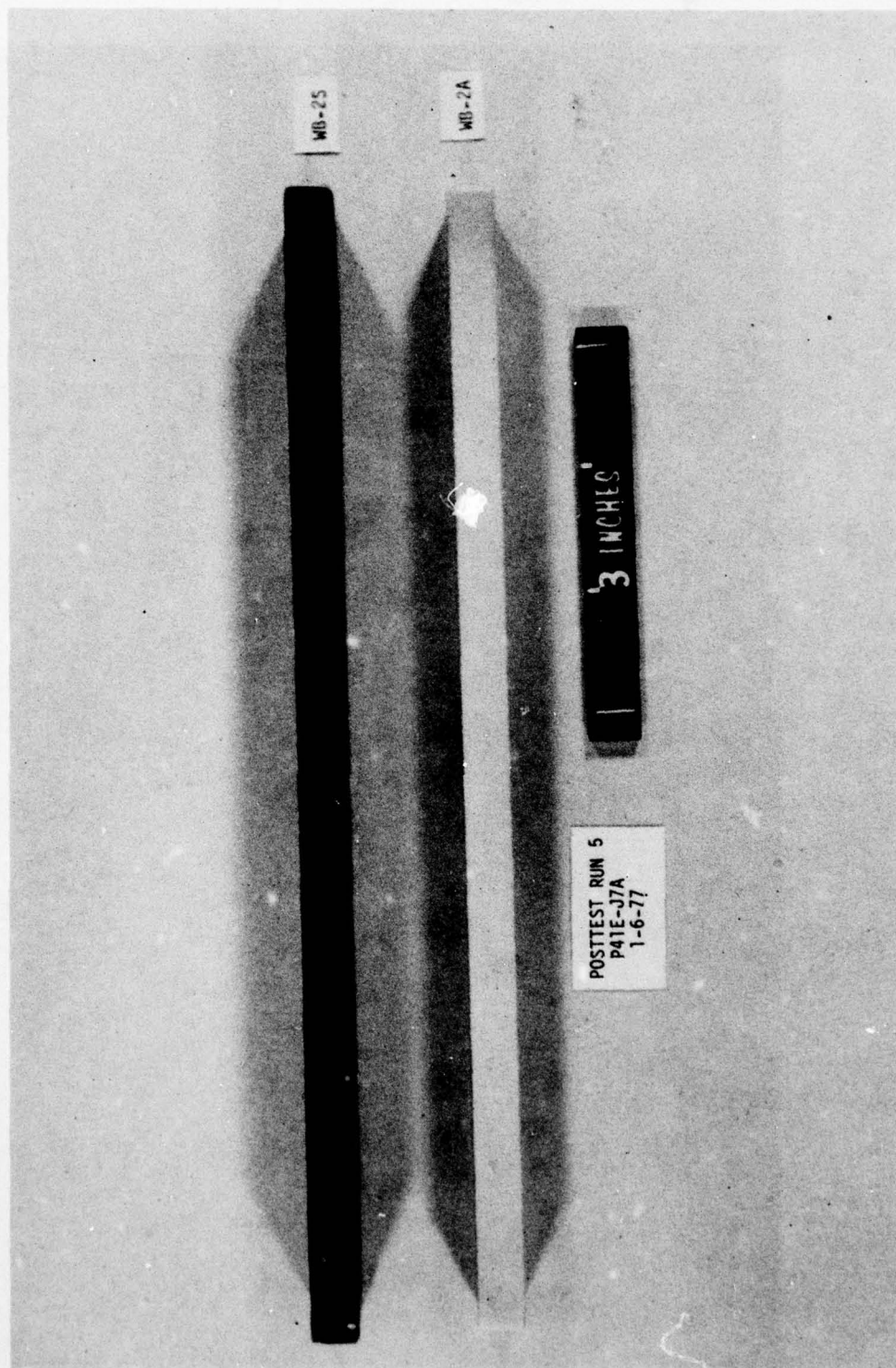


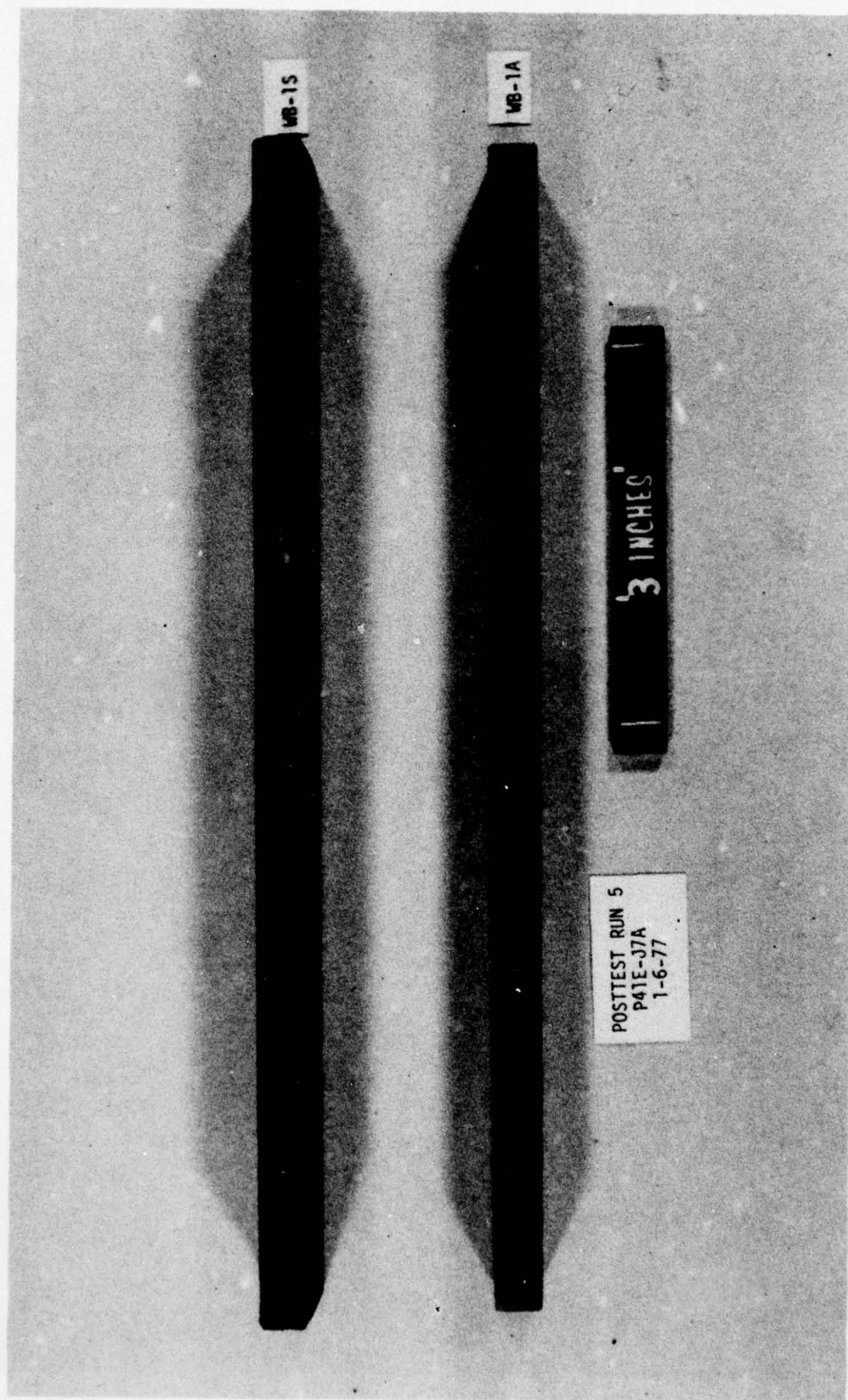








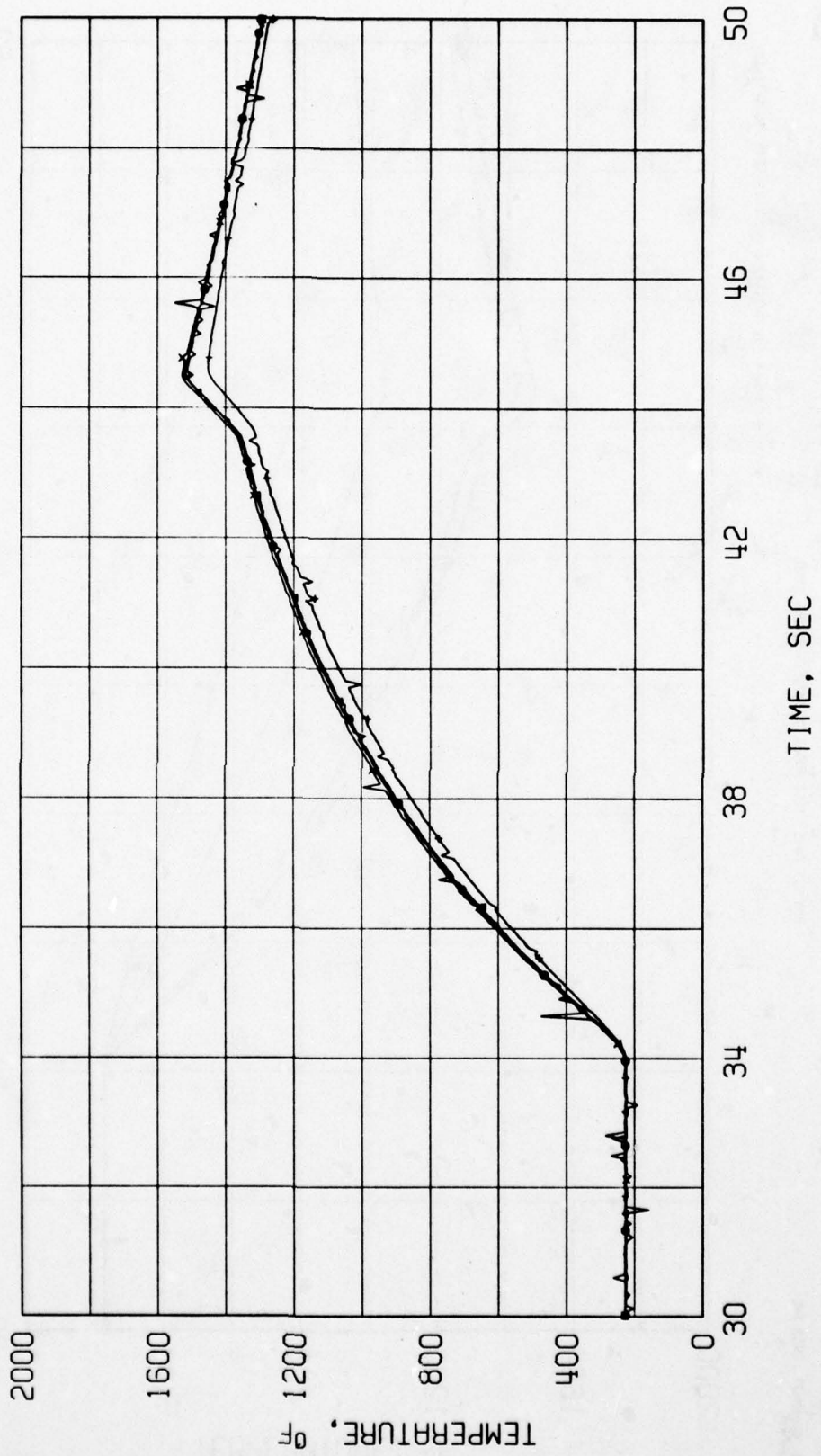




DATE 01-10-77 RND INC
PROJ-PALE

PROJECT PALE TEST R0021 DATE 01-05-77 SEL 2105

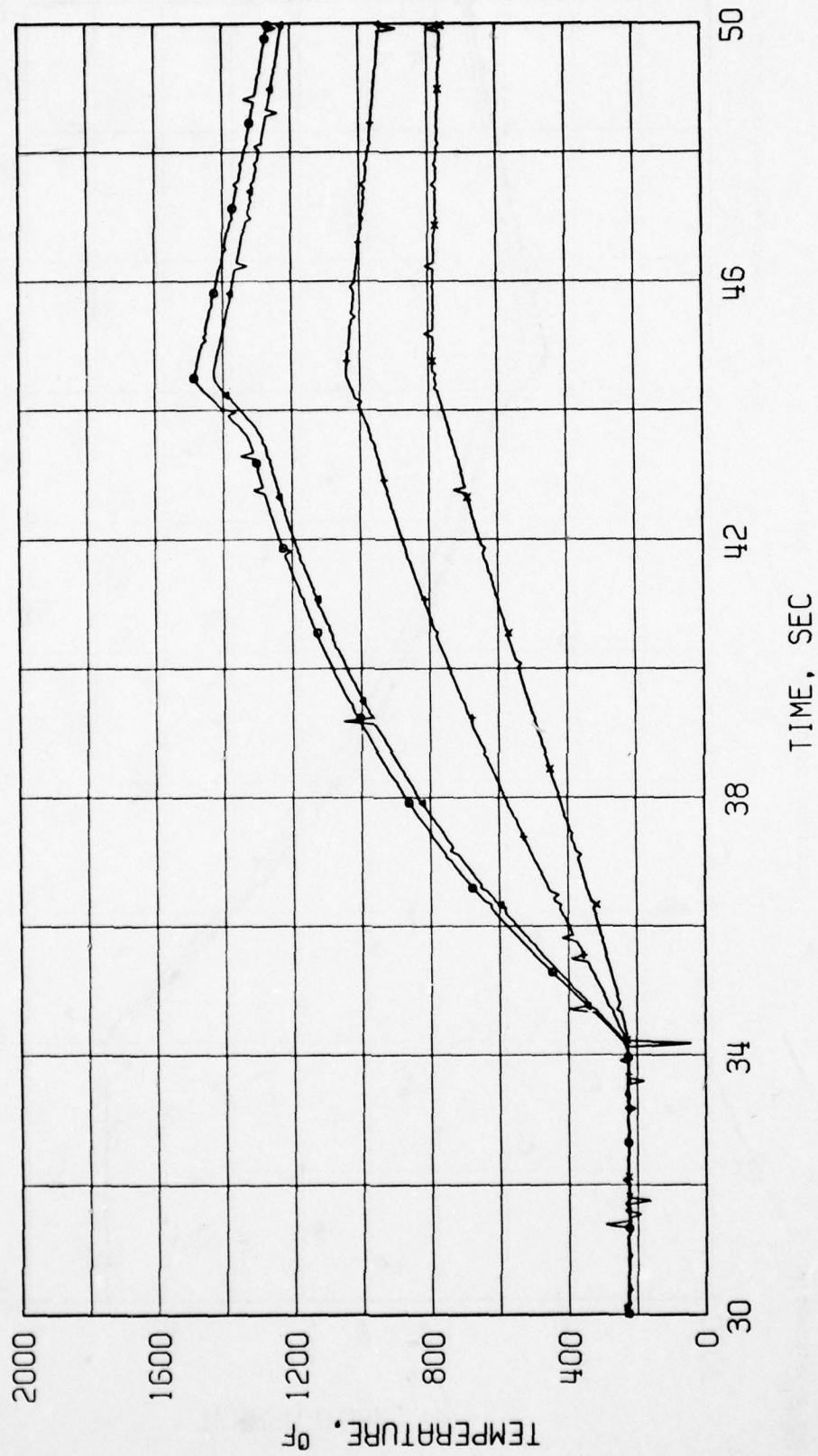
X TC-4-TI-12 + TC-3-TI-12 Δ TC-2-TI-12 ○ TC-1-TI-12



DATE 01-10-77 RNO INC
PROJ-PNIE

PROJECT PNIE TEST R0021 DATE 01-05-77 SEL 2105

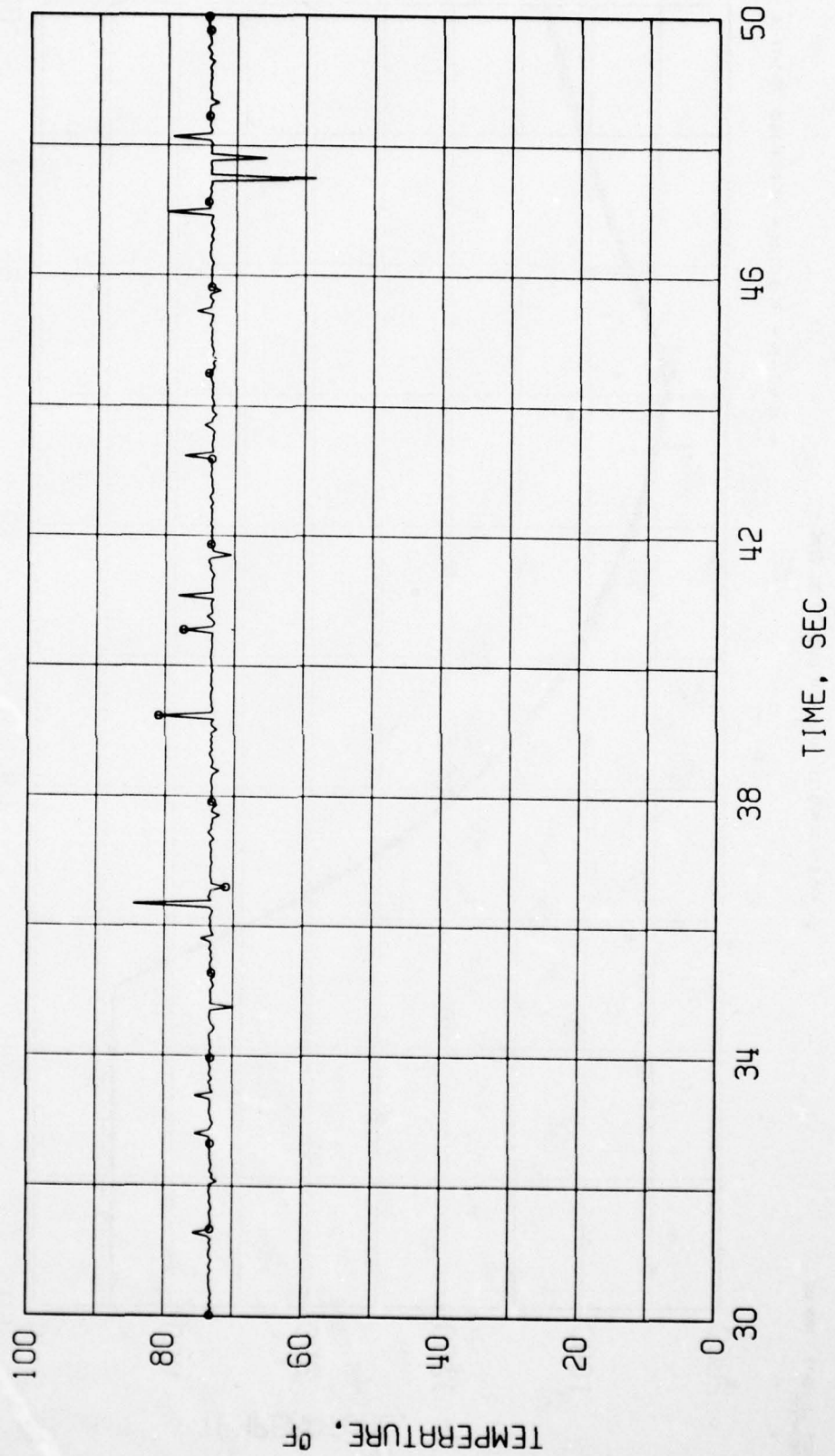
X TC-8-TI-12 + TC-7-TI-12 Δ TC-6-TI-12 ○ TC-5-TI-12



DATE 01-10-77 PRO INC
PROJ-PNIE

PROJECT PNIE TEST A0021 DATE 01-05-77 SEL 2105

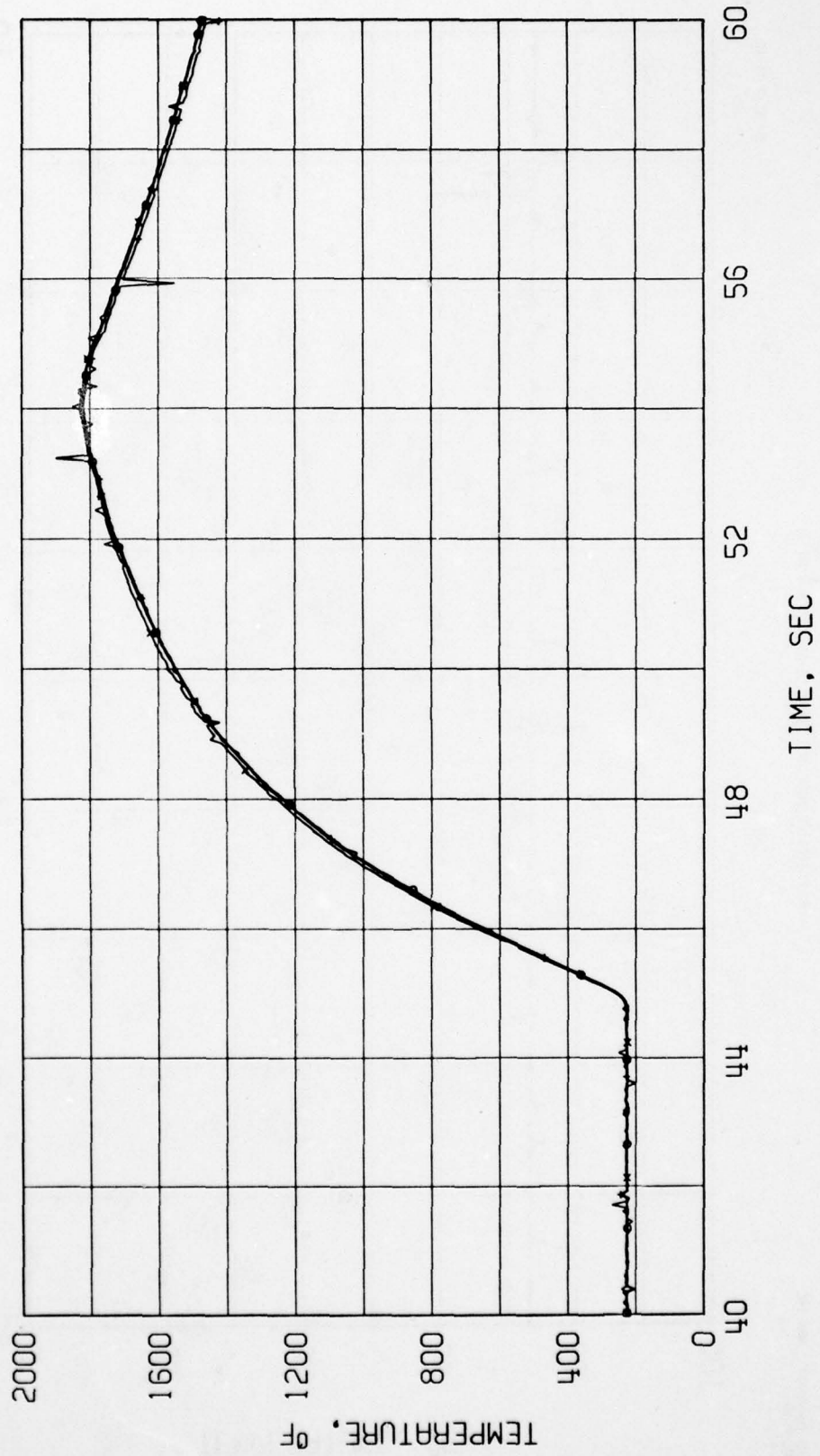
TC-9-TI-12



DATE 01-10-77 ARD INC
PROJ-PNIE

PROJECT PNIE TEST R0021 DATE 01-05-77 SEL 2105

X TC-4-TI-14 + TC-3-TI-14 Δ TC-2-TI-14 ○ TC-1-TI-14



AD-A055 886

SCIENCE APPLICATIONS INC EL SEGUNDO CALIF

F/G 11/6

TITANIUM RESPONSE TO SIMULATED NUCLEAR CLOUD PARTICLE ENVIRONME--ETC(U).

AUG 77 L E DUNBAR, R M CLEVER, G H BURGHART

DNA001-76-C-0366

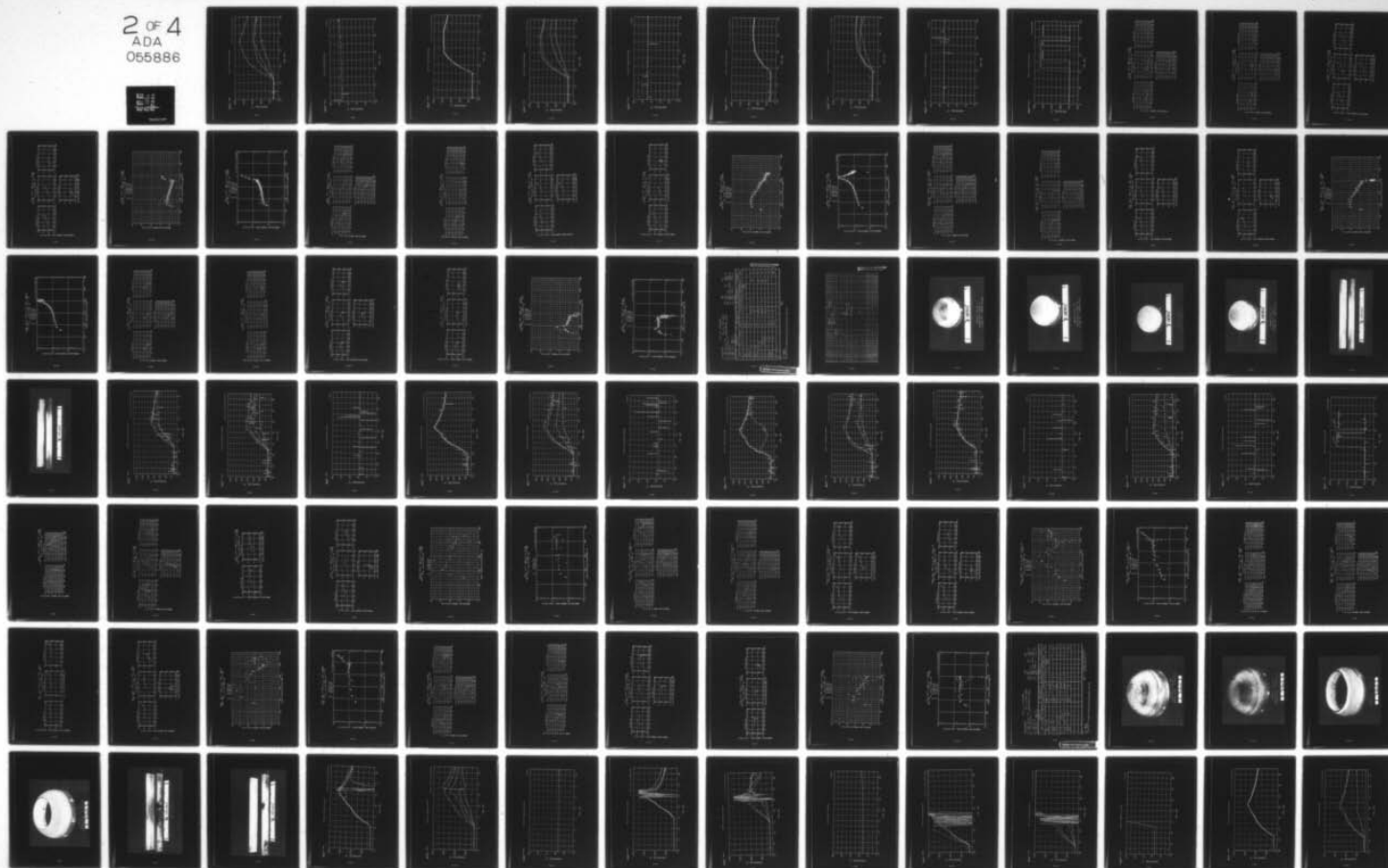
UNCLASSIFIED

SAI-78-561-LA-VOL-2

DNA-4404F-2

NL

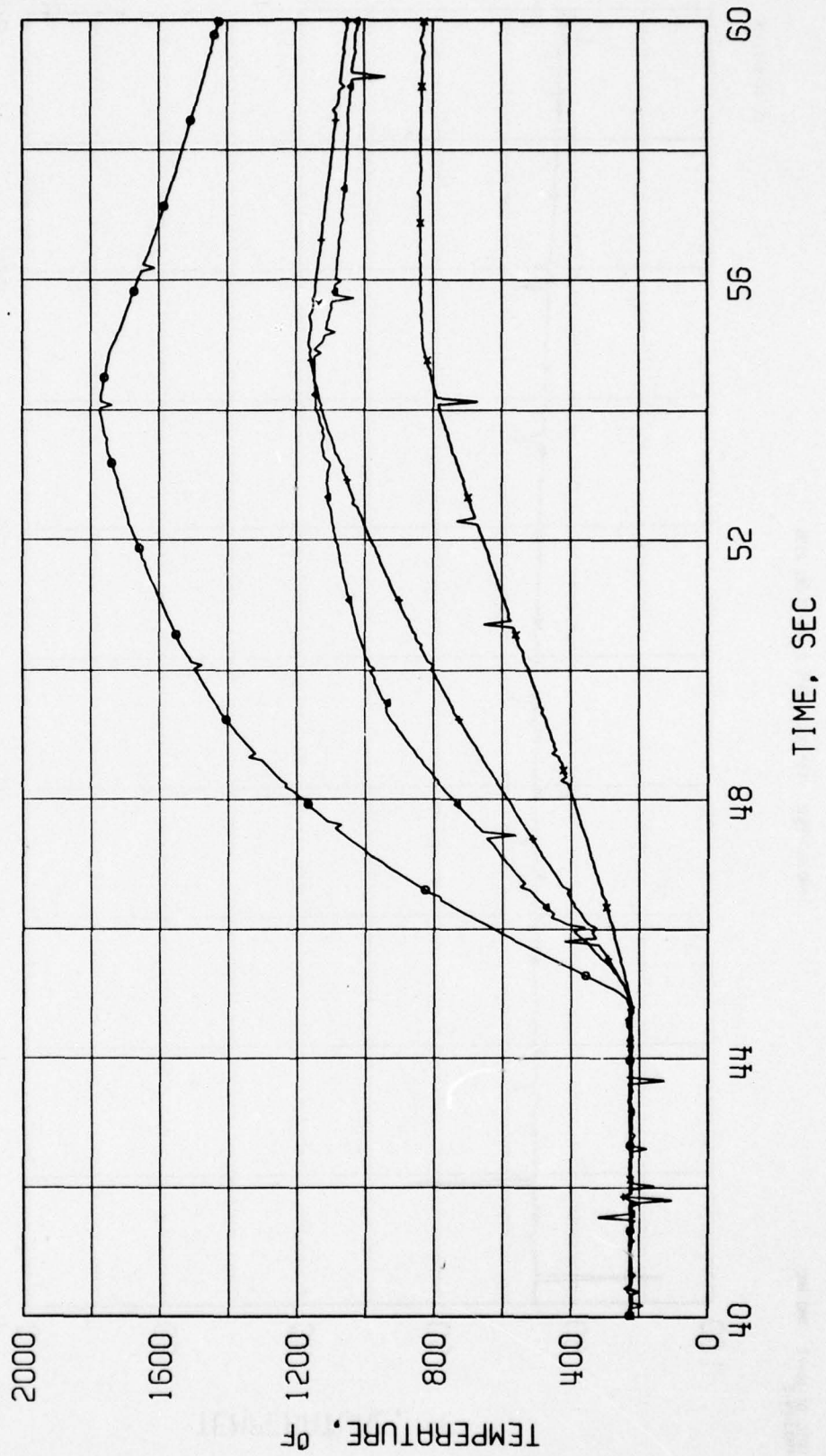
2 OF 4
ADA
055886



DATE 01-10-77 RMO INC
PROJ-P41E

PROJECT P41E TEST R0021 DATE 01-05-77 SEL 2105

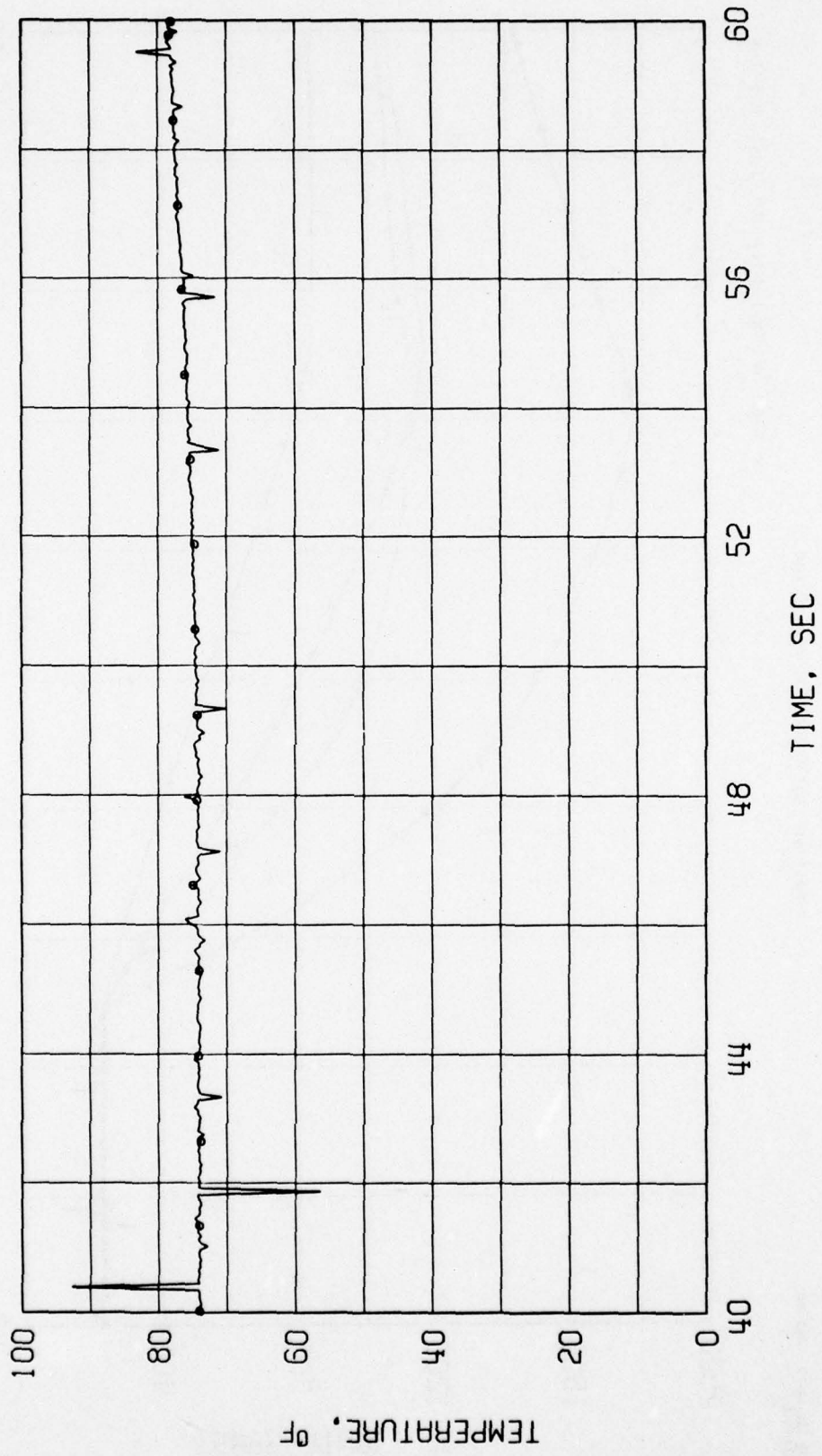
X TC-8-TI-14 + TC-7-TI-14 Δ TC-6-TI-14 ○ TC-5-TI-14



DATE 01-10-77 RRD INC
PROJ-PNIE

PROJECT PNIE TEST R0021 DATE 01-05-77 SEL 2105

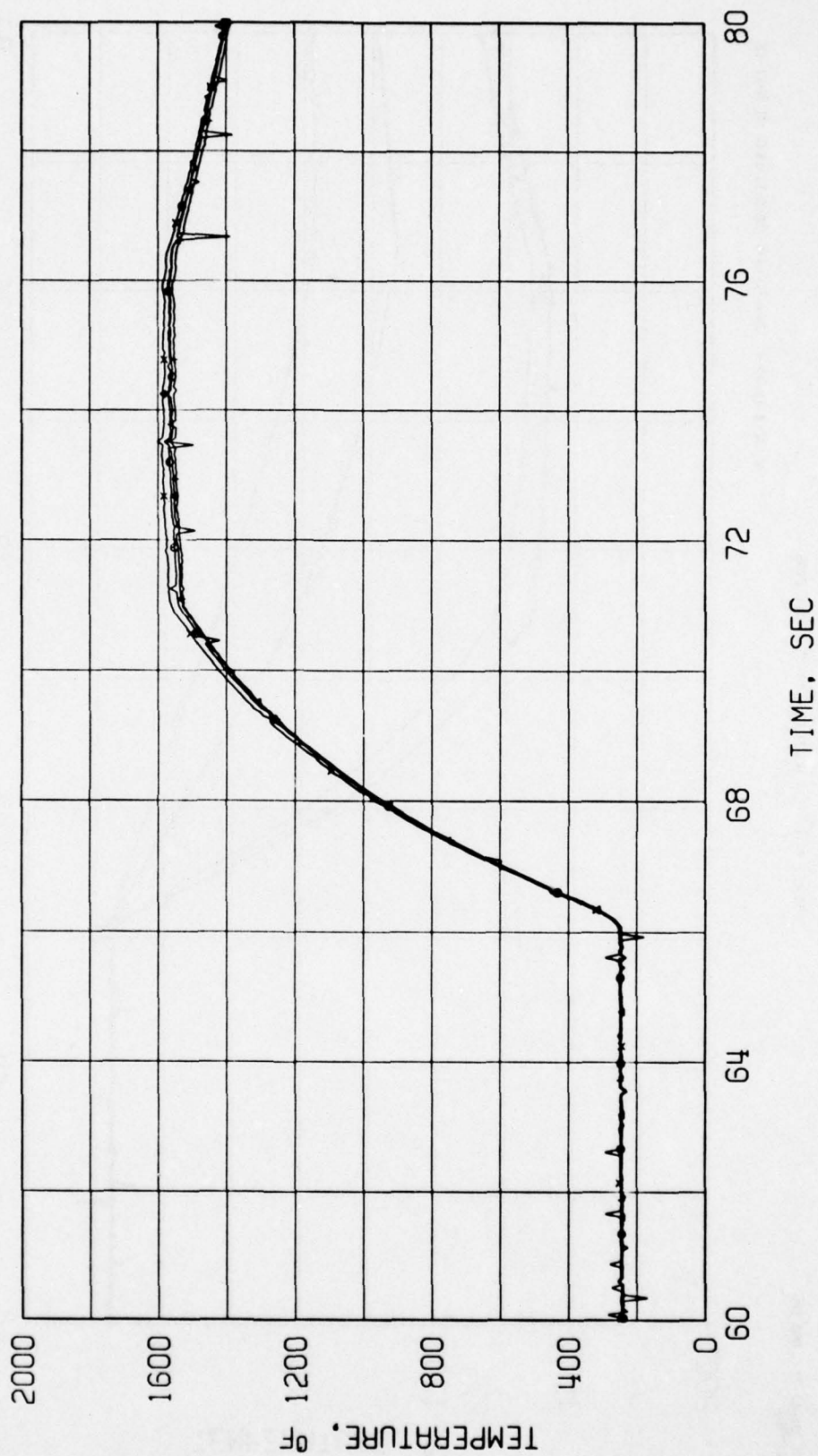
TC-9-T1-14



DATE 01-10-77 RAO INC
PROJ-PNIE

PROJECT PNIE TEST R0021 DATE 01-05-77 SEL 2105

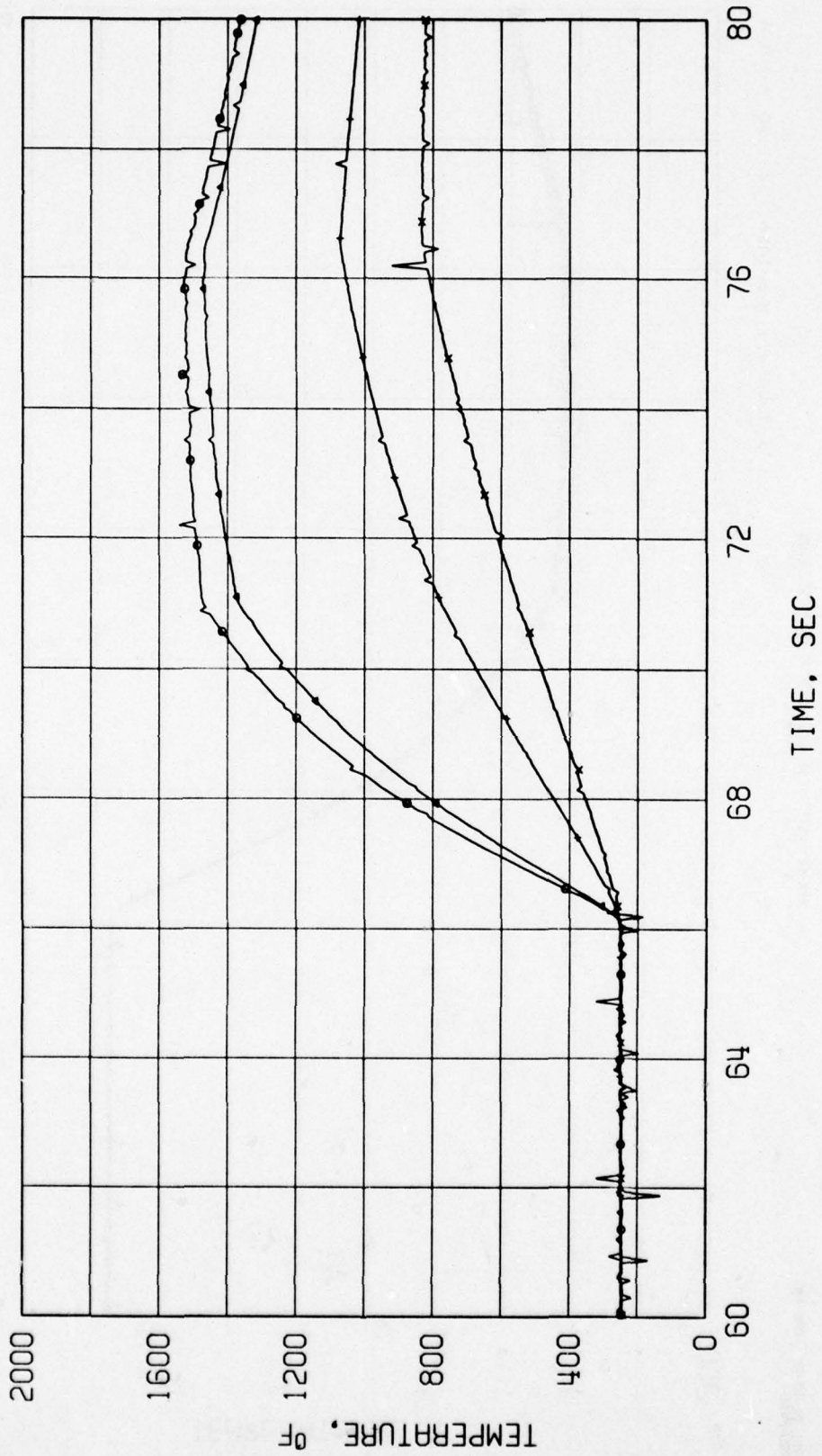
X TC-4-TI-15 + TC-3-TI-15 ▲ TC-2-TI-15 ○ TC-1-TI-15



DATE 01-10-77 PRO INC
PROJ-PHLE

PROJECT PHLE TEST R0021 DATE 01-05-77 SEL 2105

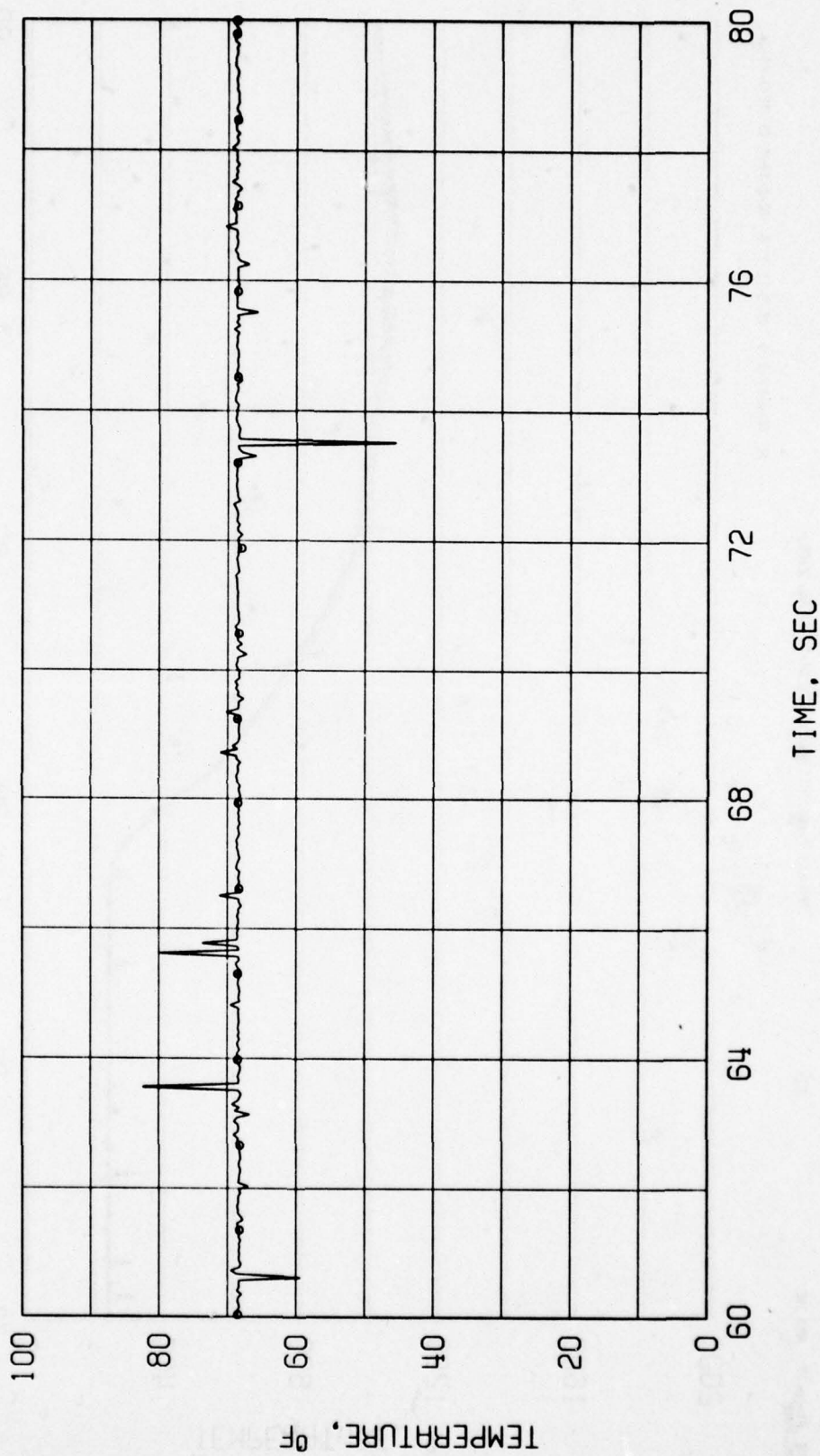
X TC-8-TI-15 + TC-7-TI-15 Δ TC-6-TI-15 ○ TC-5-TI-15



DATE 01-10-77 RND INC
PROJ-P41E

PROJECT P41E TEST R0021 DATE 01-05-77 SEL 2105

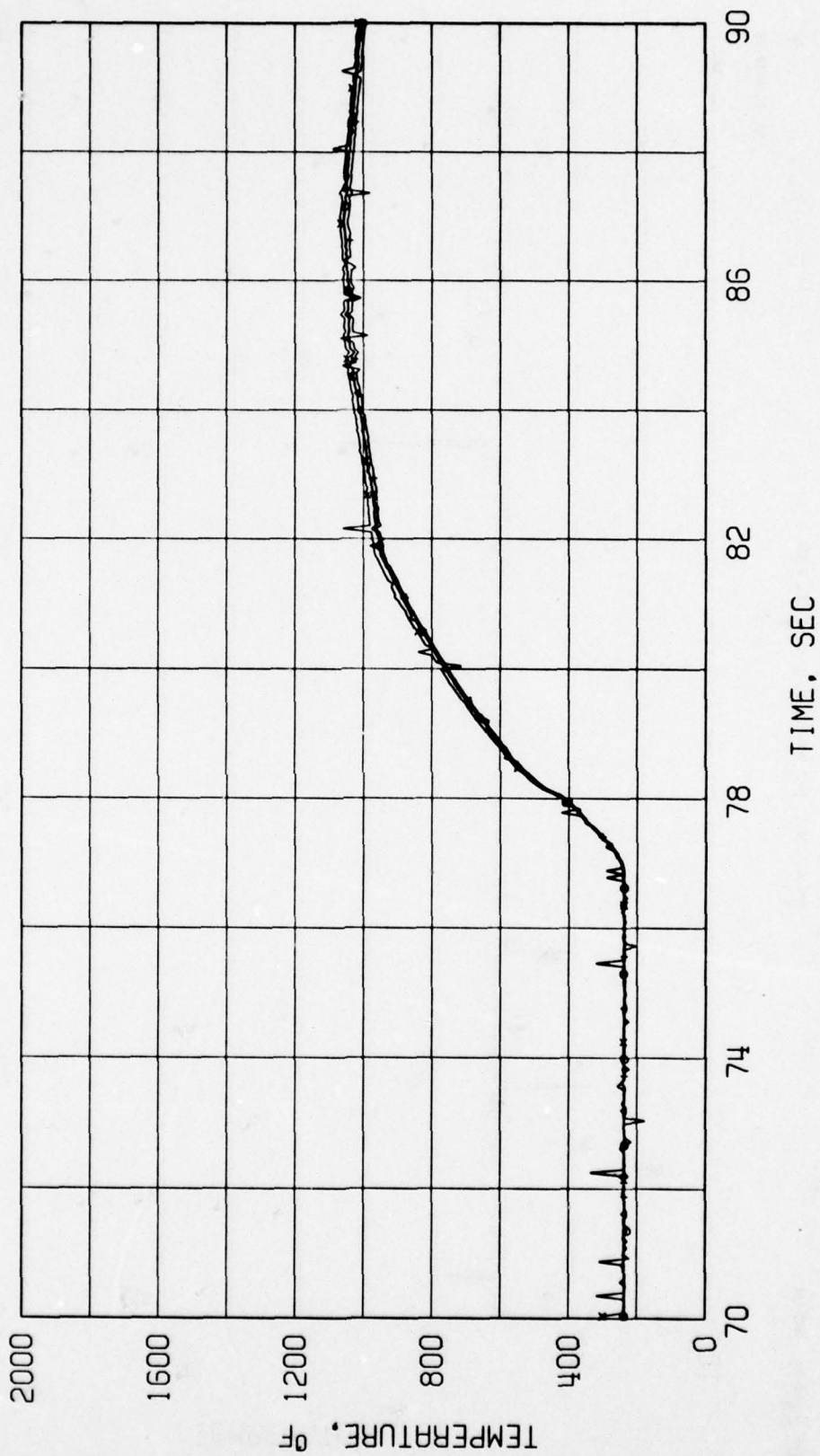
TC-9-T1-15



DATE 01-10-77 AND INC
PROJ-PNIE

PROJECT PNIE TEST R0021 DATE 01-05-77 SEL 2105

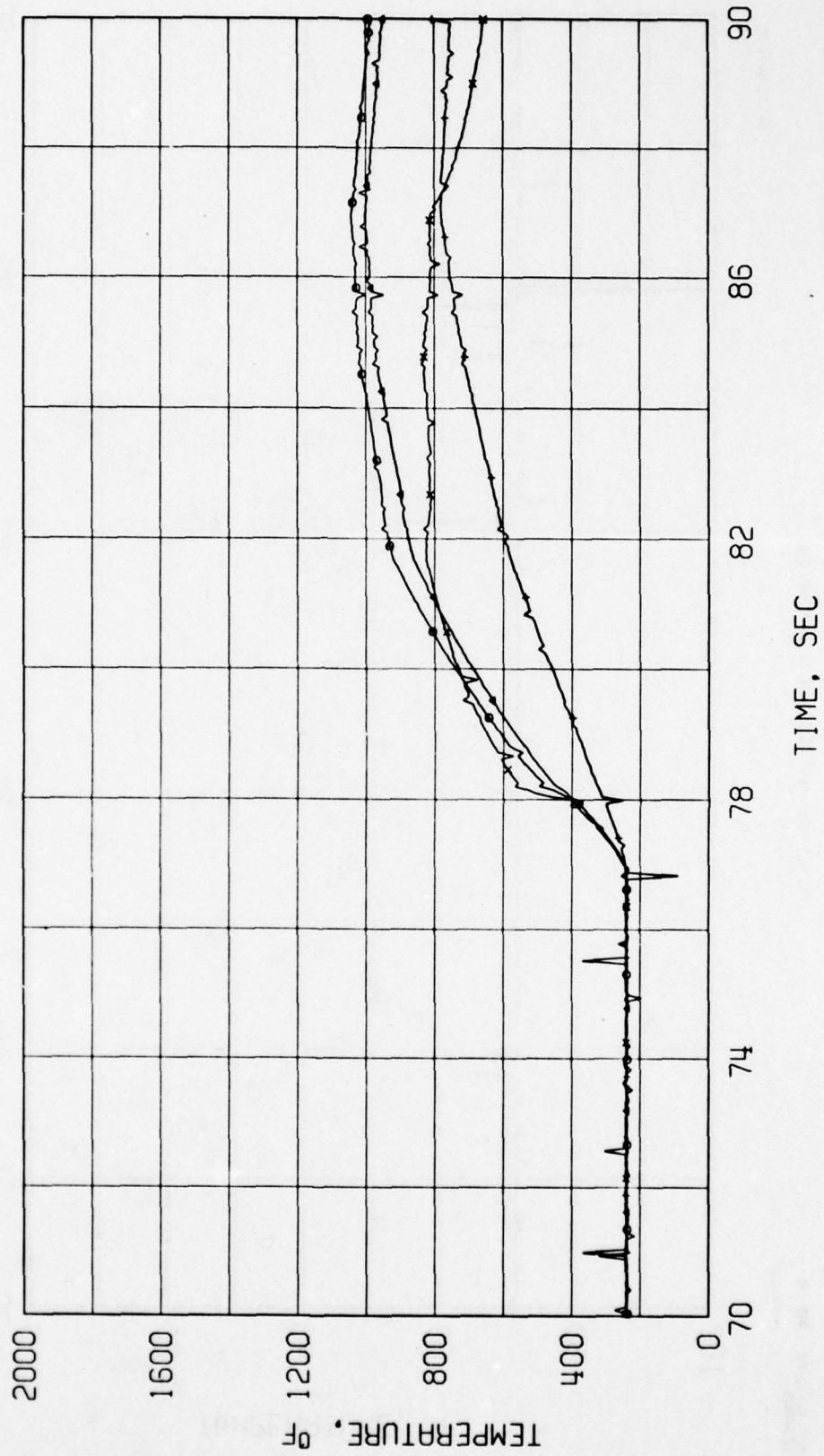
X TC-4-TI-7 + TC-3-TI-7 ▲ TC-2-TI-7 ○ TC-1-TI-7



DATE 01-10-77 RND INC
PROJ-PNIE

PROJECT PNIE TEST R0021 DATE 01-05-77 SEL 2105

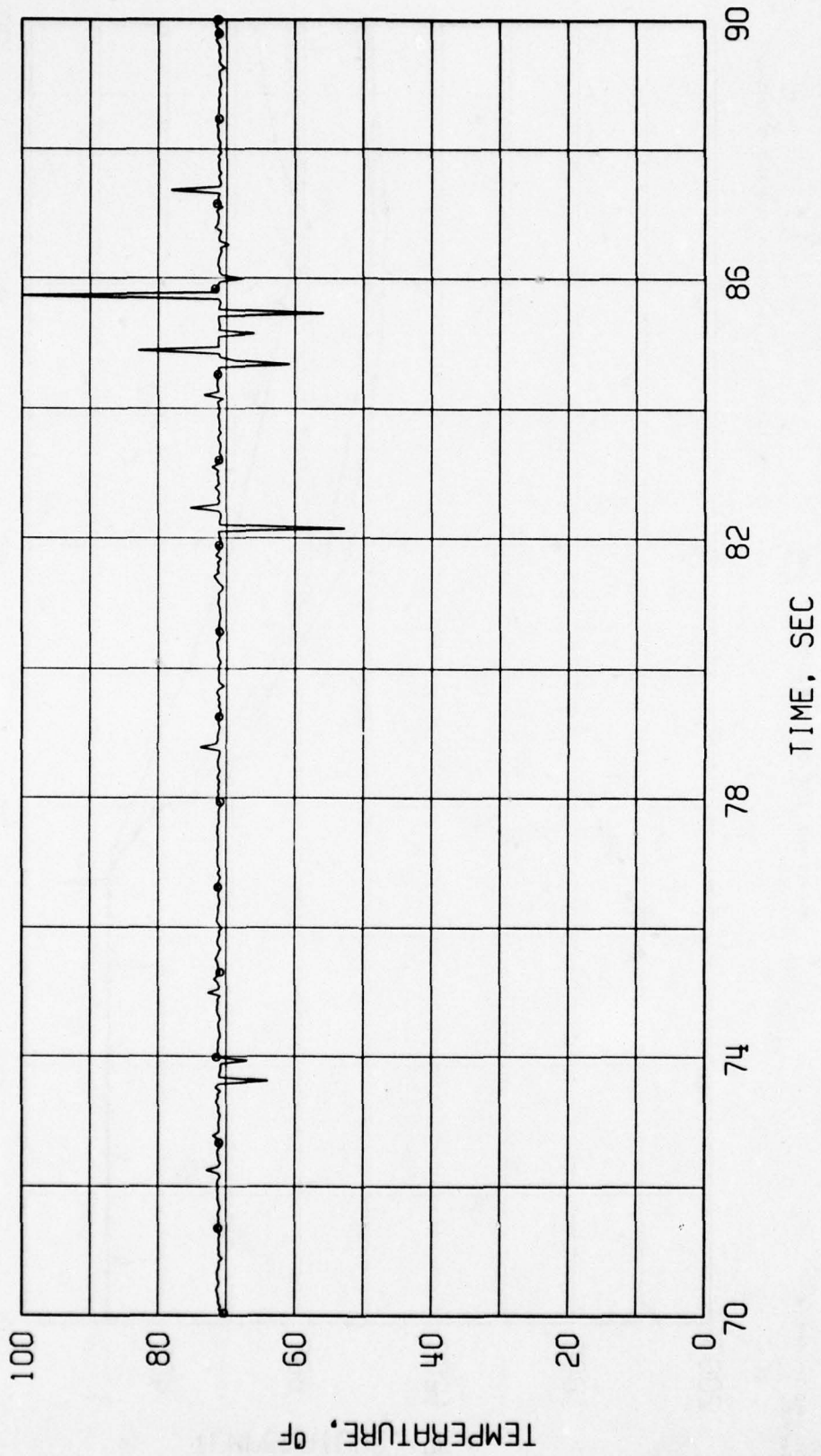
X TC-8-TI-7 + TC-7-TI-7 ▲ TC-6-TI-7 ○ TC-5-TI-7



DATE 01-10-77 PRO INC
PROJ-PNIE

PROJECT PNIE TEST R0021 DATE 01-05-77 SEL 2105

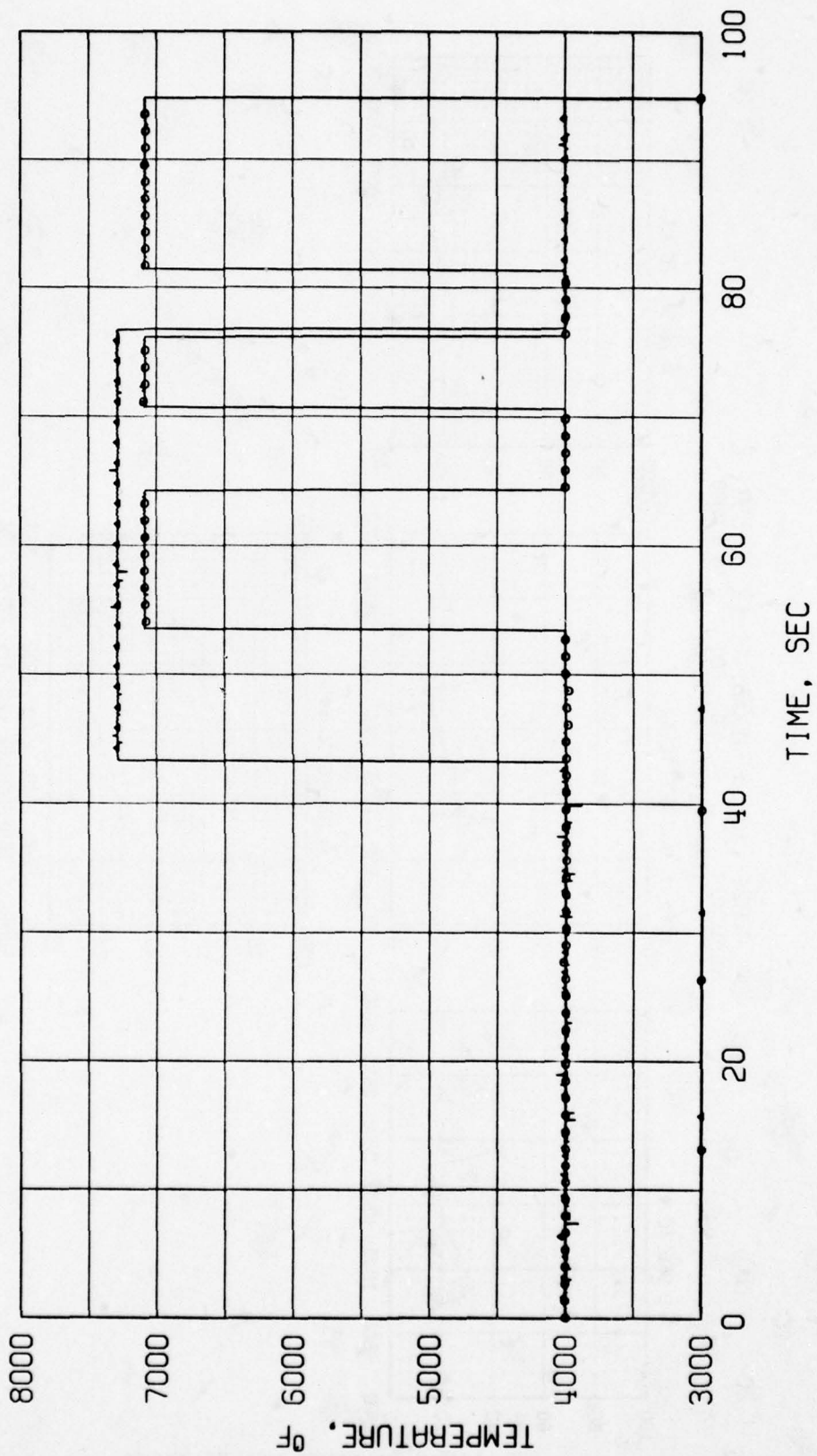
TC-9-TI-7



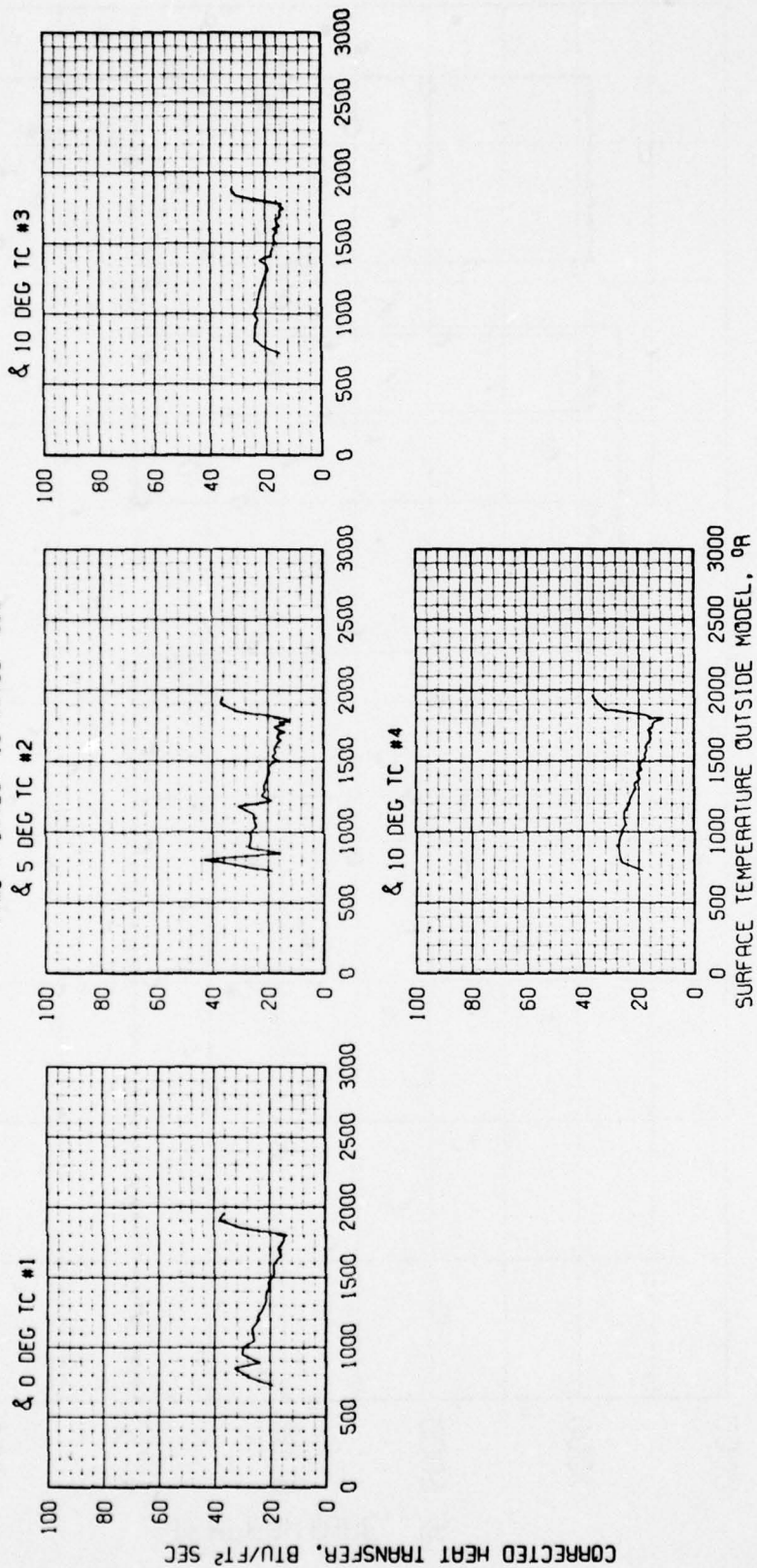
DATE 01-10-77 PROJ-PALE

PROJECT PALE TEST R0021 DATE 01-05-77 SEL 2105

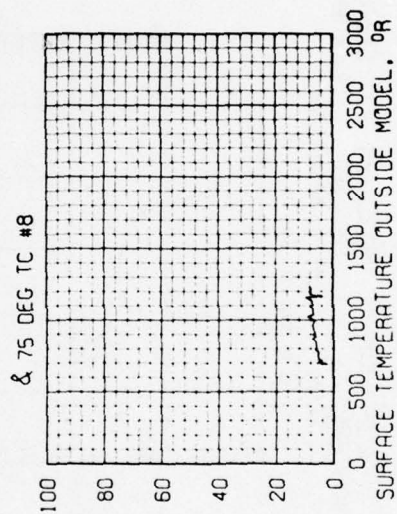
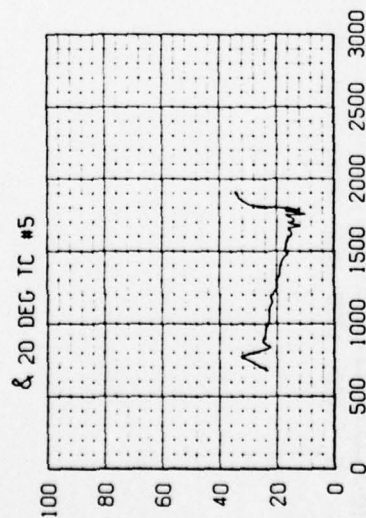
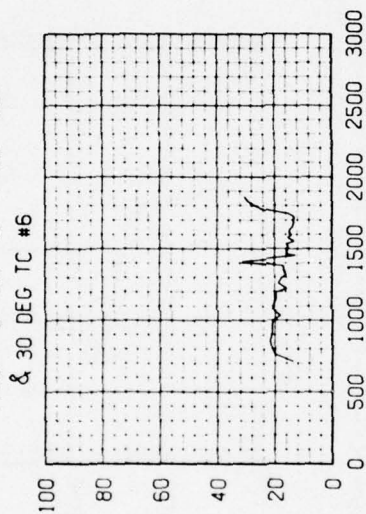
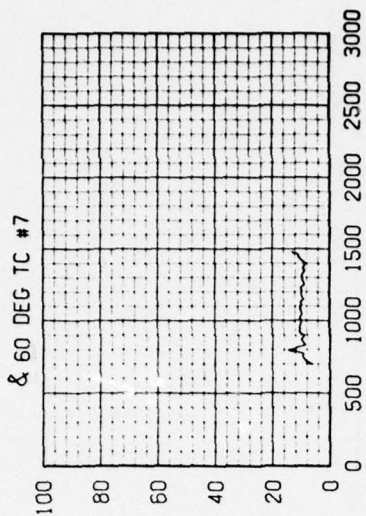
▲ DUST-EVENT ○ H2O-EVENT



AD0021 RUN 5 MODEL TI-12 CLEAR
 MODEL HEMI P0 = 500 T0 = 2030
 Time = 34.23 to 44.60 Sec



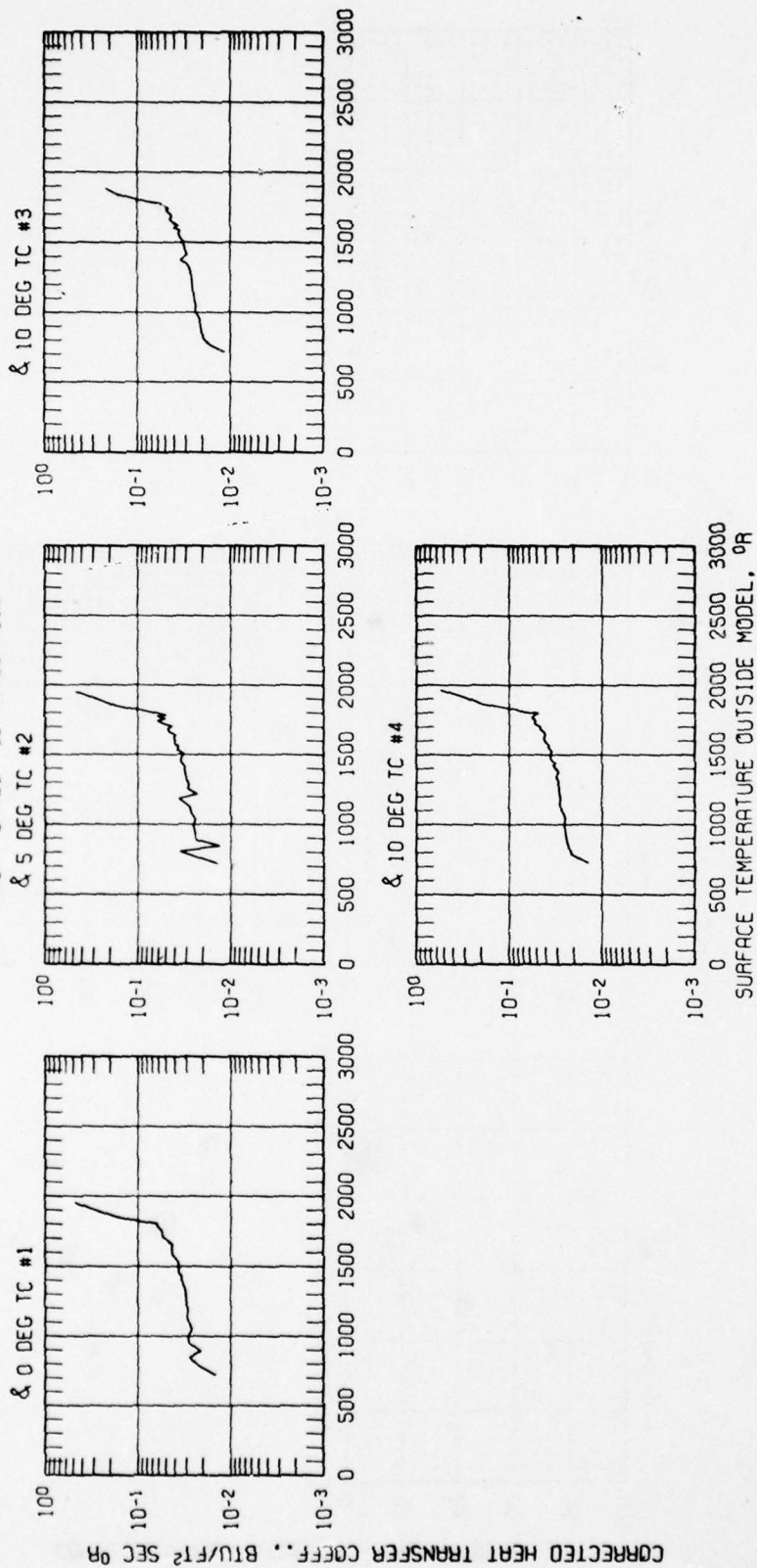
AD021 RUN 5 MODEL T1-12 CLEAR
 MODEL HEM1 PO = 500 TO = 2030
 Time = 34.23 to 44.60 Sec



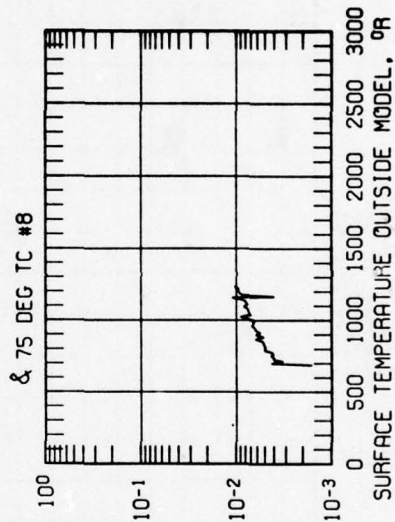
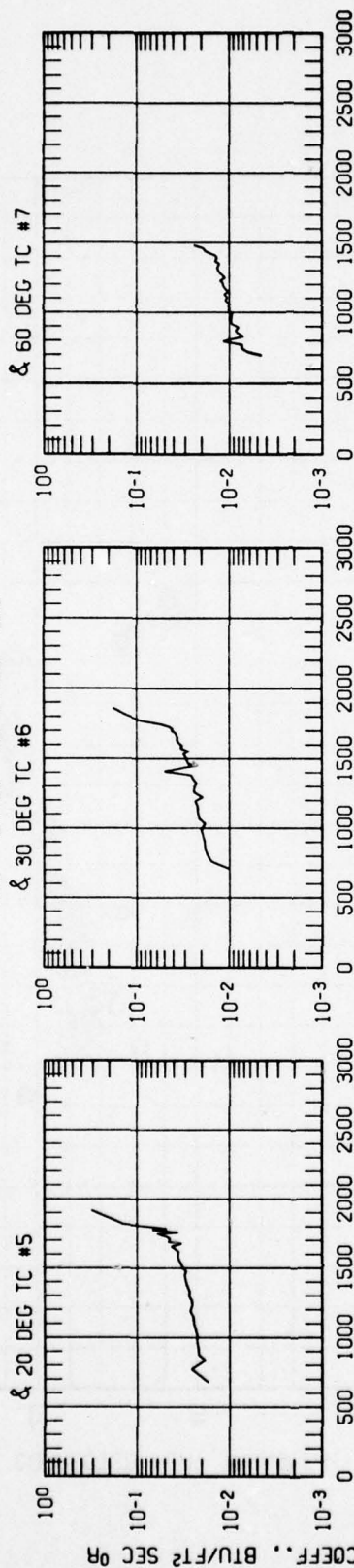
CORRECTED HEAT TRANSFER, BTU/FT² SEC

SURFACE TEMPERATURE OUTSIDE MODEL, °R

A0021 RUN 5 MODEL T1-12 CLEAR
 MODEL HEM1
 Time = 34.23 to 44.60 Sec
 PO = 500 TO = 2030



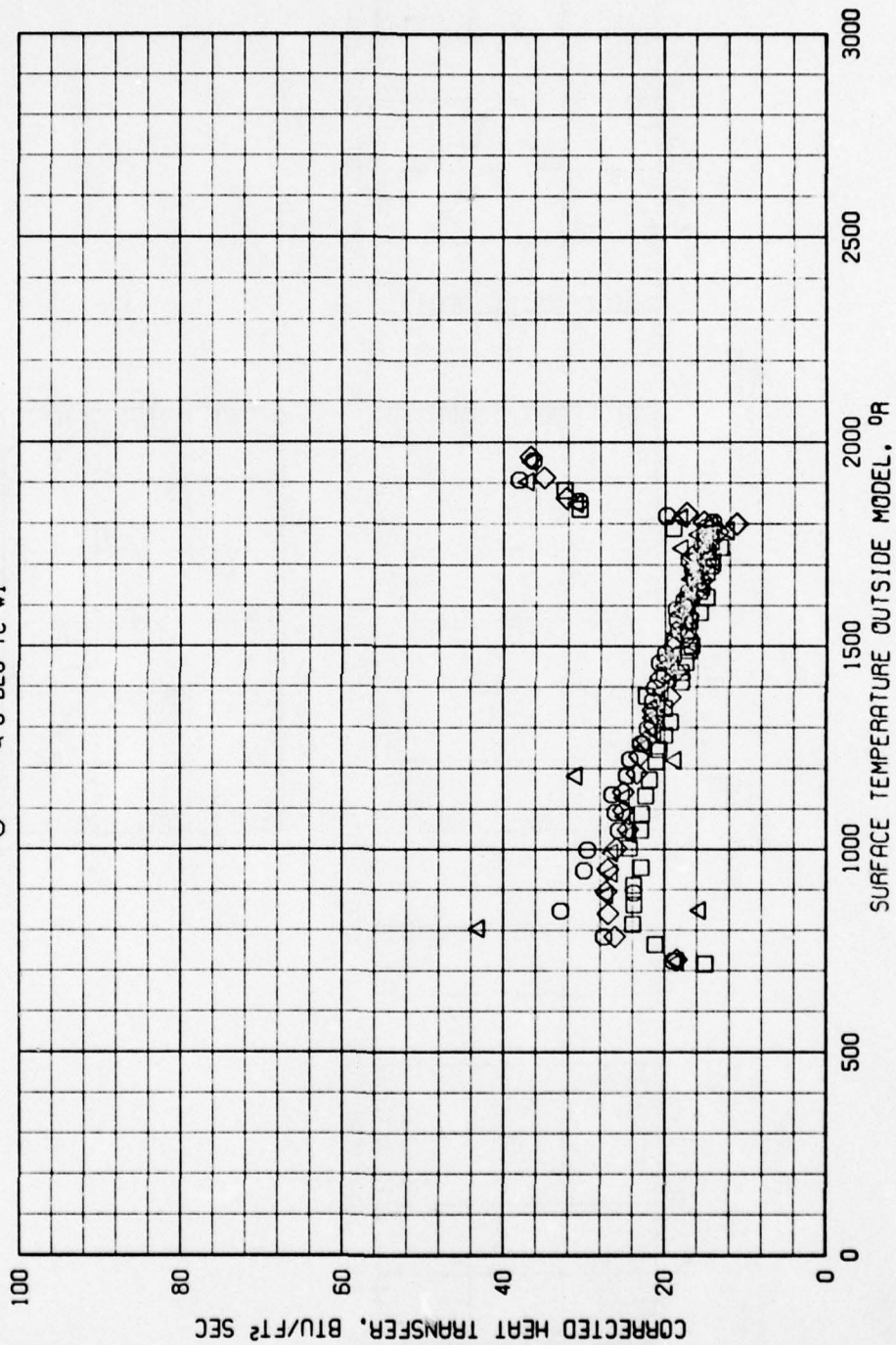
AD021 RUN 5 MODEL TI-12 CLEAR
 MODEL HEM1 PO = 500 TO = 2030
 Time = 34.23 to 44.60 Sec



CORRECTED HEAT TRANSFER COEFF., BTU/FT² SEC °R

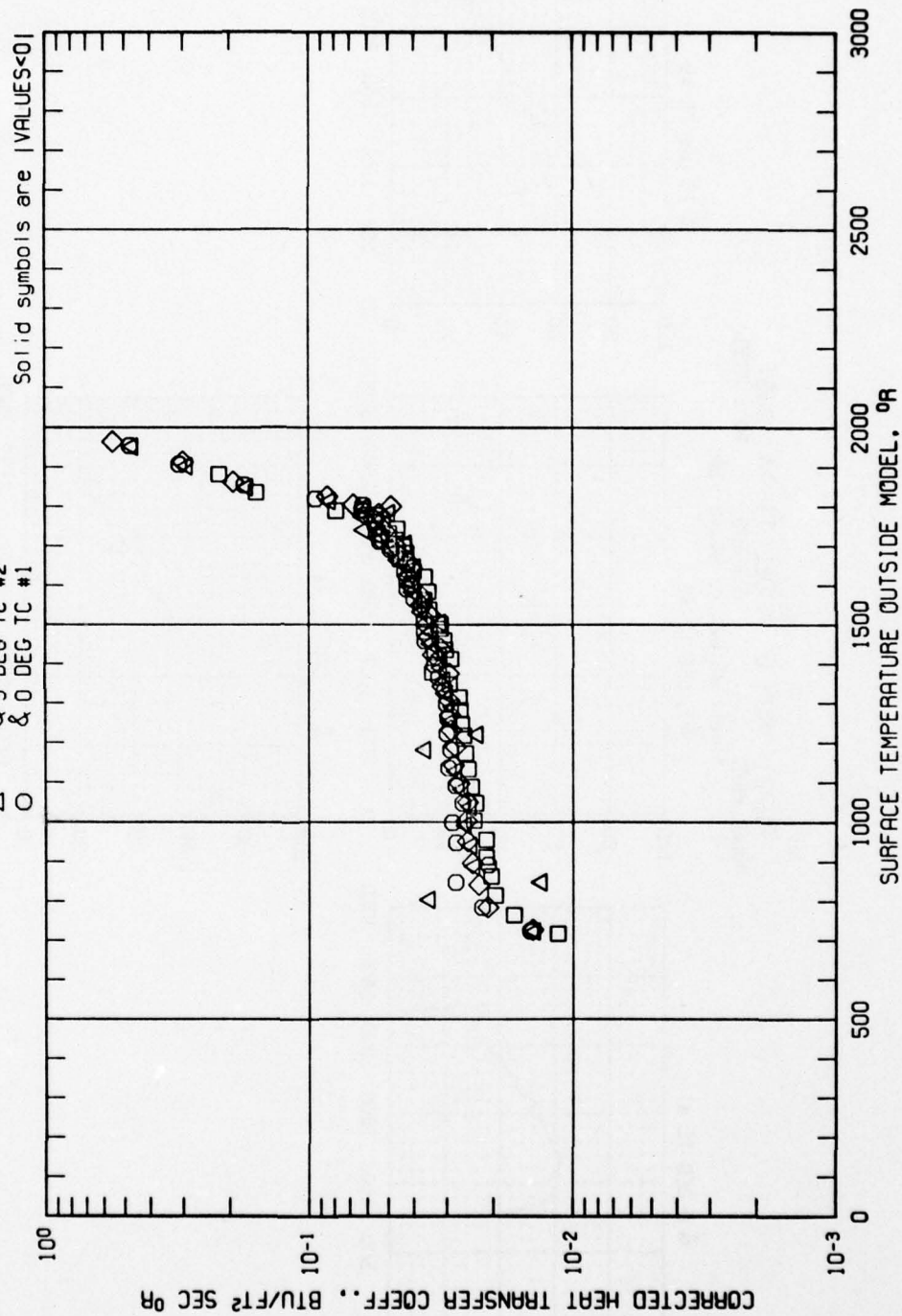
0 500 1000 1500 2000 2500 3000
 SURFACE TEMPERATURE OUTSIDE MODEL, °R

AD021 RUN 5 MODEL TI-12 CLEAR
 MODEL HEMI P0 = 500 T0 = 2030
 Time = 34.23 to 44.60 Sec
 & 10 DEG TC #4
 & 10 DEG TC #3
 & 5 DEG TC #2
 & 0 DEG TC #1

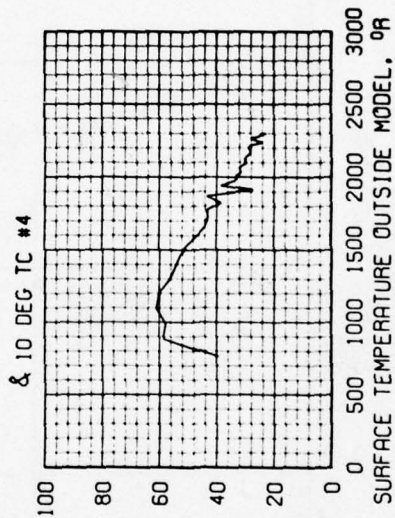
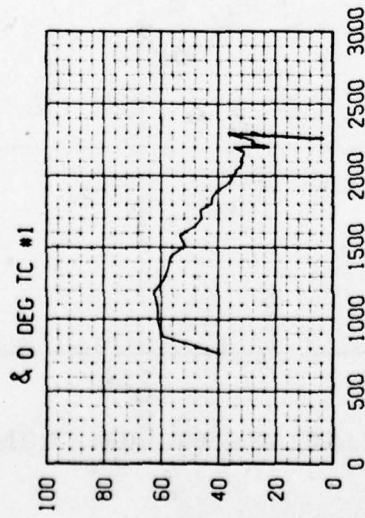
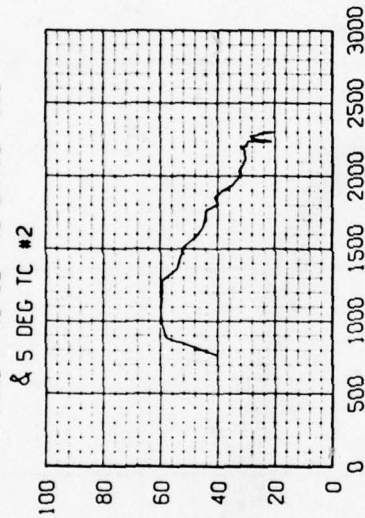
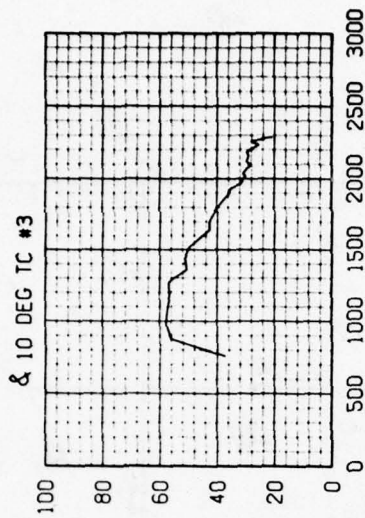


AD021 RUN 5 MODEL TI-12 CLEAR
 MODEL HEM1 P0 = 500 T0 = 2030
 Time = 34.23 to 44.60 Sec

◇ & 10 DEG TC #4
 □ & 10 DEG TC #3
 △ & 5 DEG TC #2
 ○ & 0 DEG TC #1

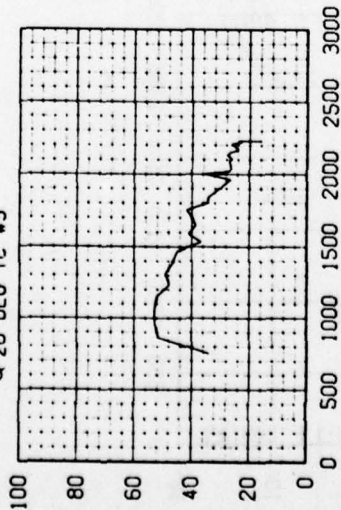


AD021 RUN 5 MODEL TI-14 DUST
 MODEL HEMI P0 = 500 T0 = 2030
 Time = 45.02 to 54.40 Sec



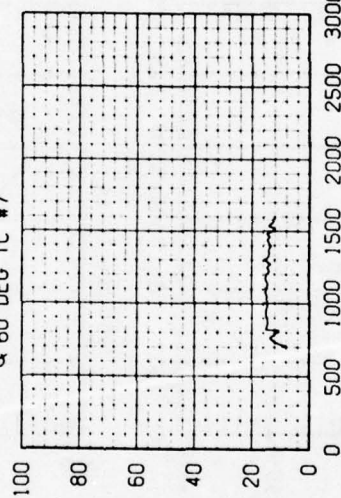
CORRECTED HEAT TRANSFER, BTU/FT² SEC

& 20 DEG TC #5

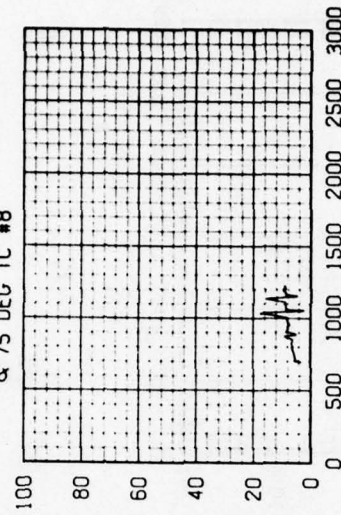


AD021 RUN 5 MODEL TI-14 DUST
MODEL HEMI P0 = 500 T0 = 2030
Time = 45.02 to 54.40 Sec

& 60 DEG TC #7

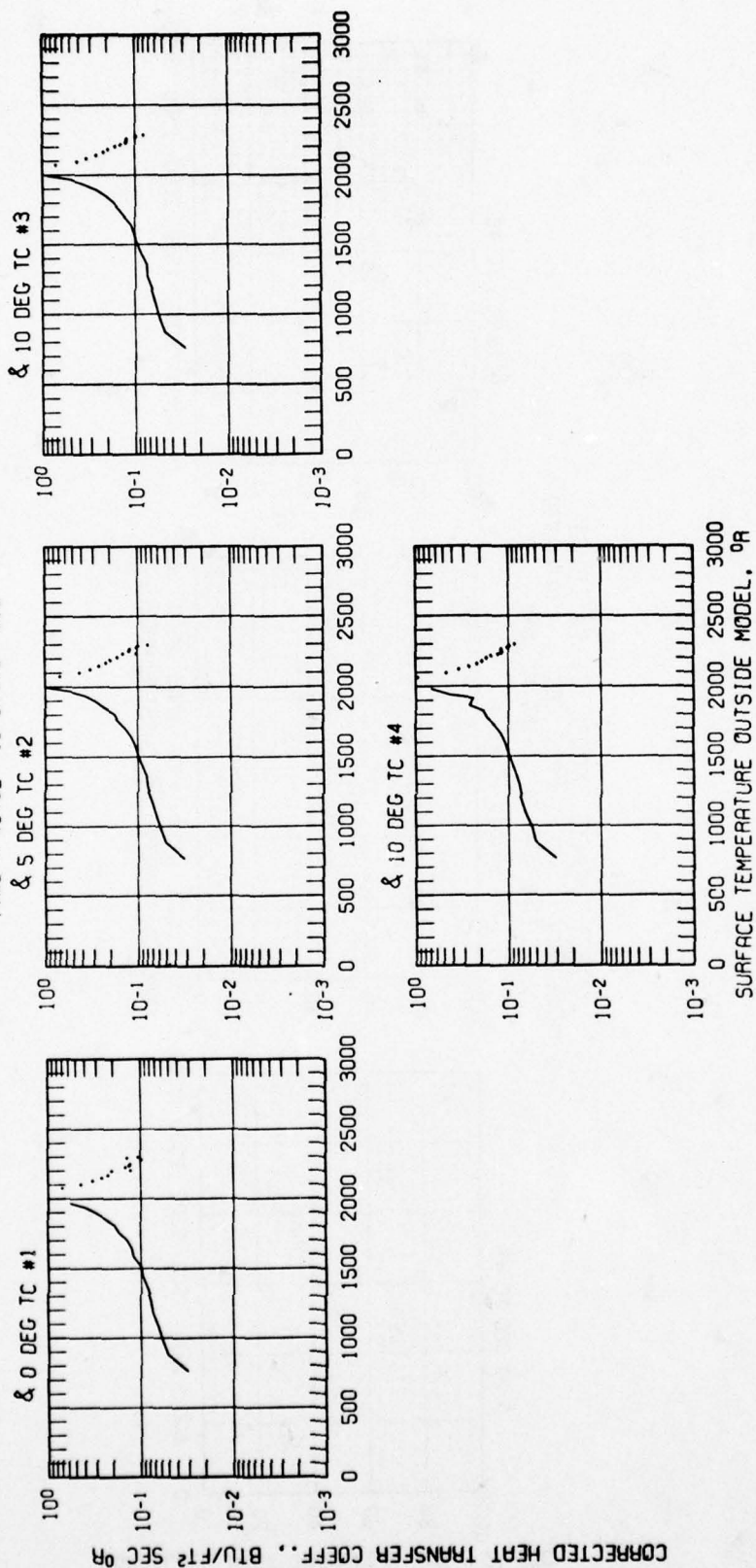


& 75 DEG TC #8

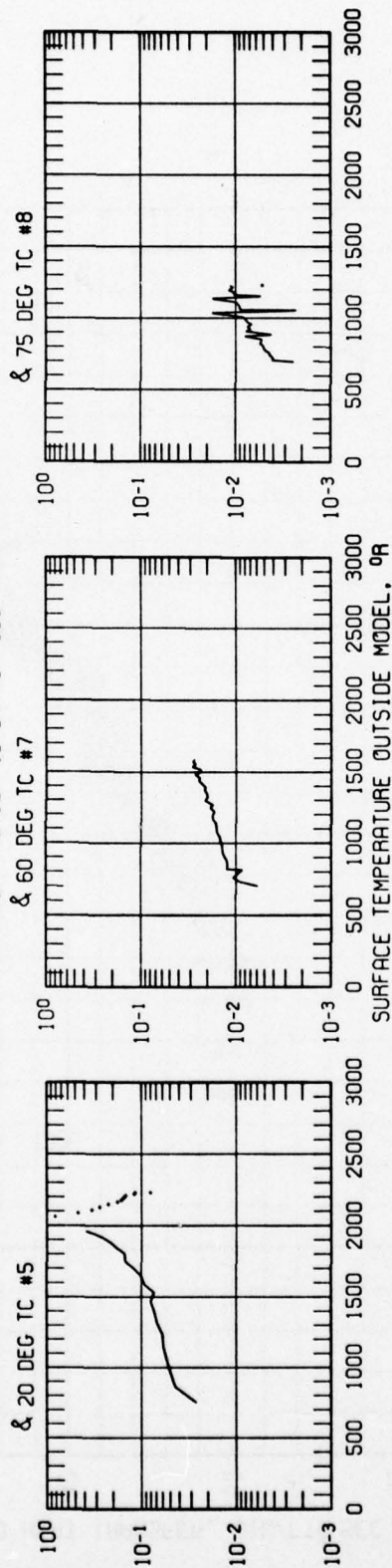


SURFACE TEMPERATURE OUTSIDE MODEL, °R

AD021 RUN 5 MODEL TI-14 DUST
 MODEL HEMI P0 = 500 T0 = 2030
 Time = 45.02 to 54.40 Sec



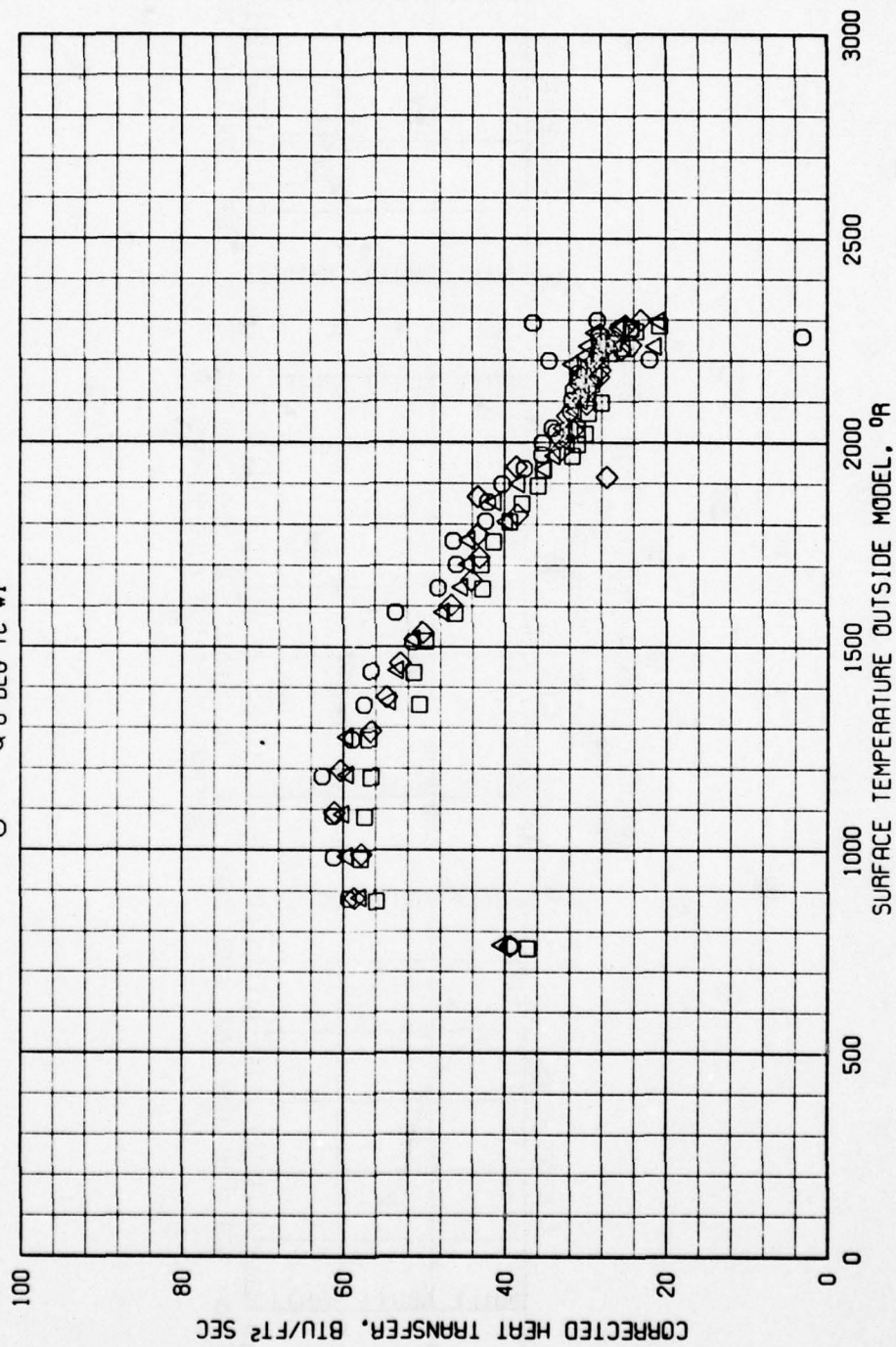
CORRECTED HEAT TRANSFER COEFF., BTU/FT² SEC °R



AD021 RUN 5 MODEL TI-14 DUST
MODEL HEMI P0 = 500 T0 = 2030
Time = 45.02 to 54.40 Sec

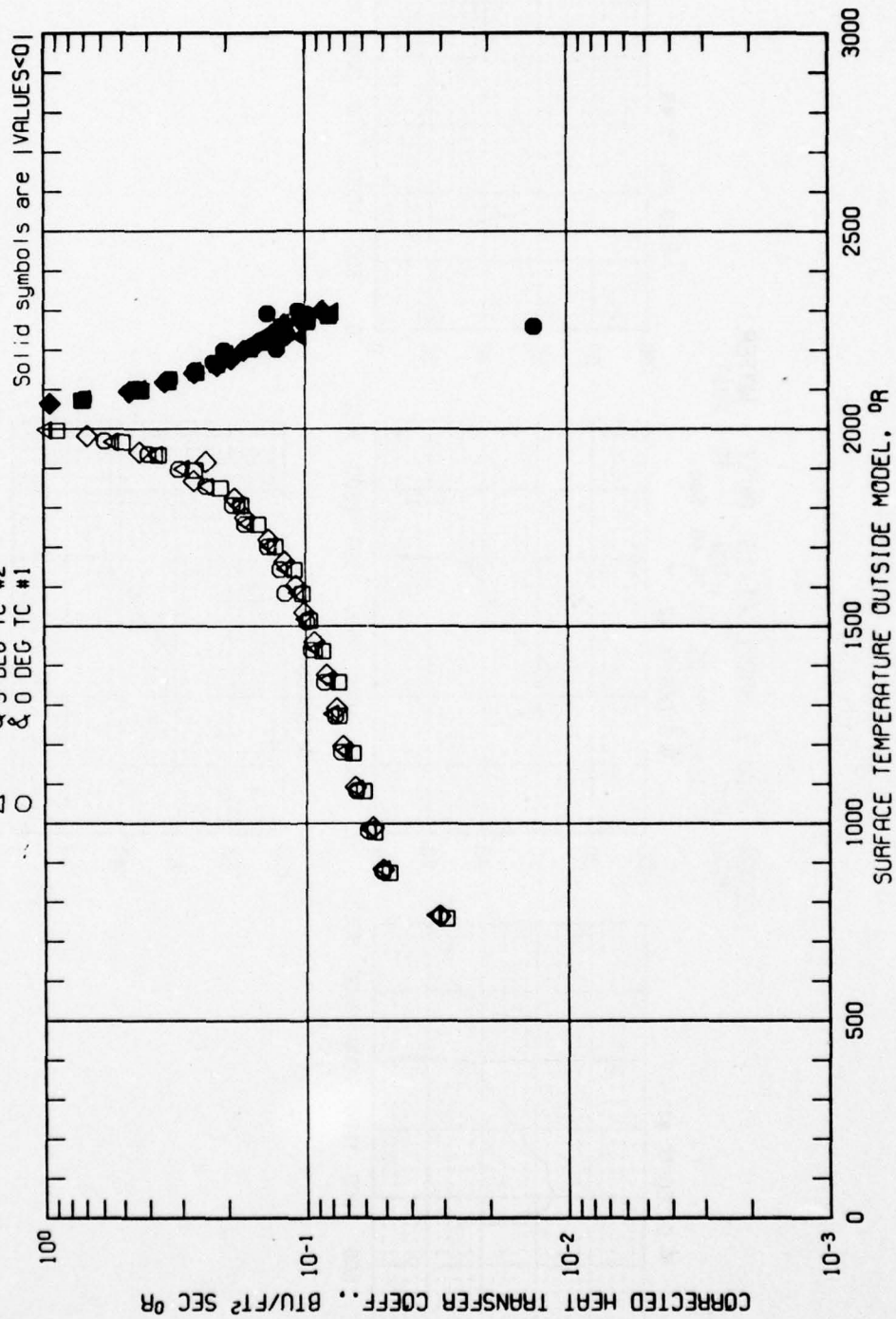
AD021 RUN 5 MODEL T1-14 DUST
 MODEL HEMI P0 = 500 T0 = 2030
 Time = 45.02 to 54.40 Sec

◇ 10 DEG TC #4
 □ 10 DEG TC #3
 △ 5 DEG TC #2
 ○ 0 DEG TC #1

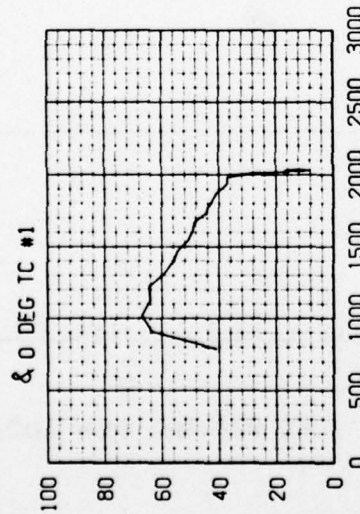
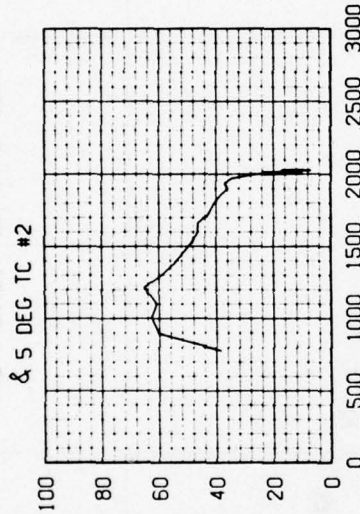
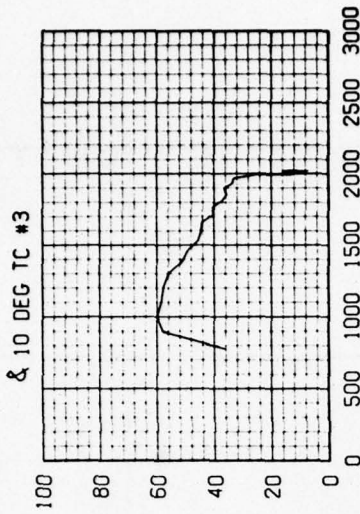


AD021 RUN 5 MODEL TI-14 DUST
 MODEL HEMI P0 = 500 T0 = 2030
 Time = 45.02 to 54.40 Sec

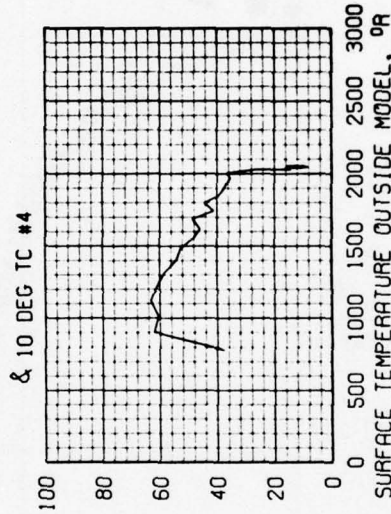
◇ 10 DEG TC #4
 □ 10 DEG TC #3
 △ 5 DEG TC #2
 ○ 0 DEG TC #1



AD021 RUN 5 MODEL T1-15 DUST + WATER
 MODEL HEM1 P0 = 500 T0 = 2030
 Time = 56.25 to 76.40 Sec

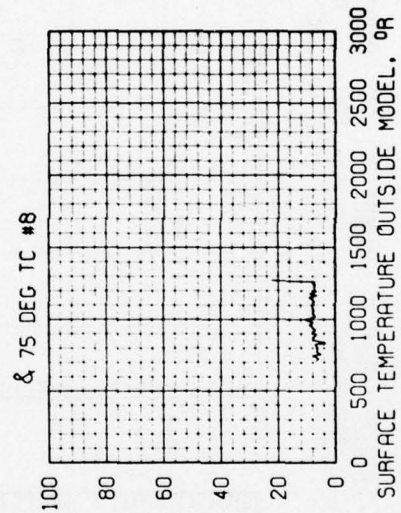
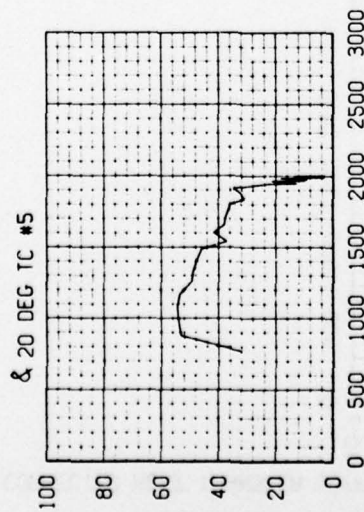
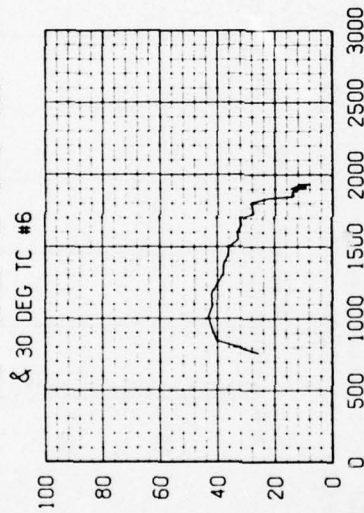
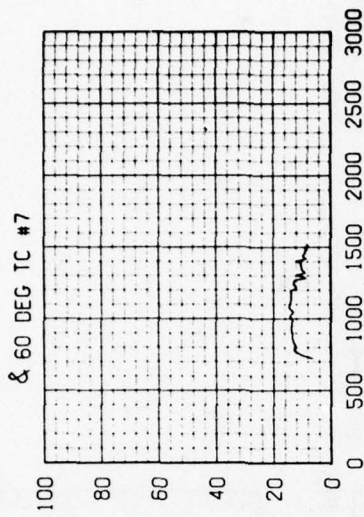


CORRECTED HEAT TRANSFER, BTU/FT² SEC



SURFACE TEMPERATURE OUTSIDE MODEL, °R

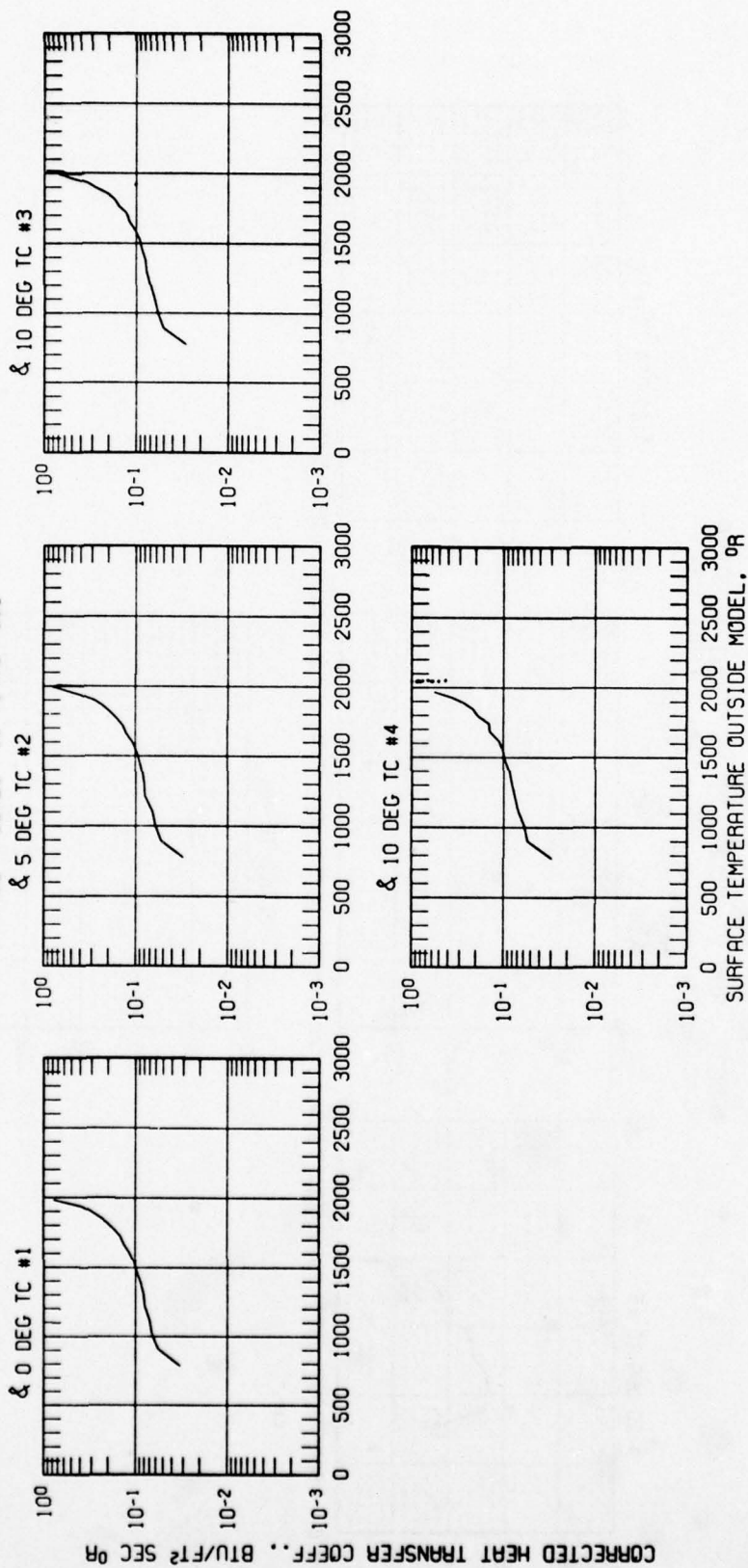
AD0021 RUN 5 MODEL T1-15 DUST + WATER
 MODEL HEMI P0 = 500 T0 = 2030
 Time = 66.25 to 76.40 Sec



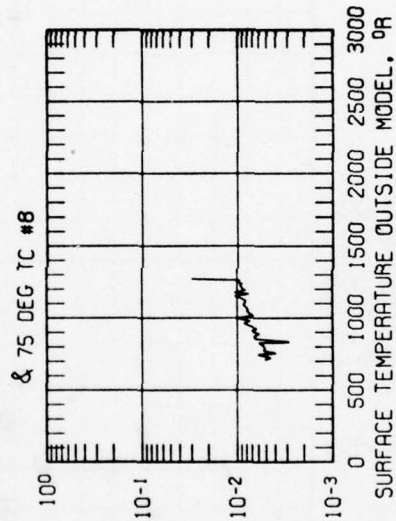
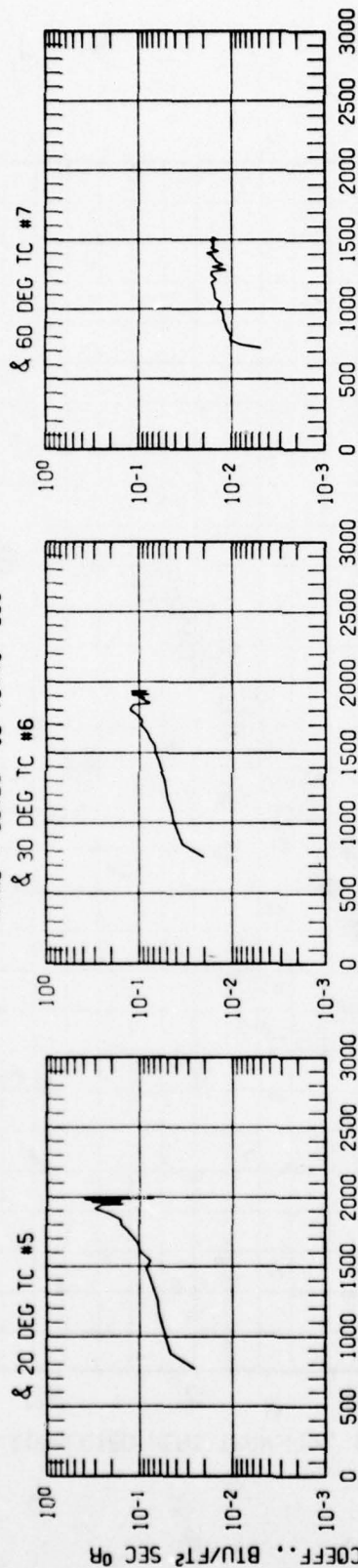
CORRECTED HEAT TRANSFER, BTU/FT² SEC

0 500 1000 1500 2000 2500 3000
 SURFACE TEMPERATURE OUTSIDE MODEL, OR

AD021 RUN 5 MODEL TI-15 DUST + WATER
 MODEL HEMI P0 = 500 T0 = 2030
 Time = 66.25 to 76.40 Sec



AD021 RUN 5 MODEL T1-15 DUST + WATER
 MODEL HEMI P0 = 500 T0 = 2030
 Time = 66.25 to 76.40 Sec

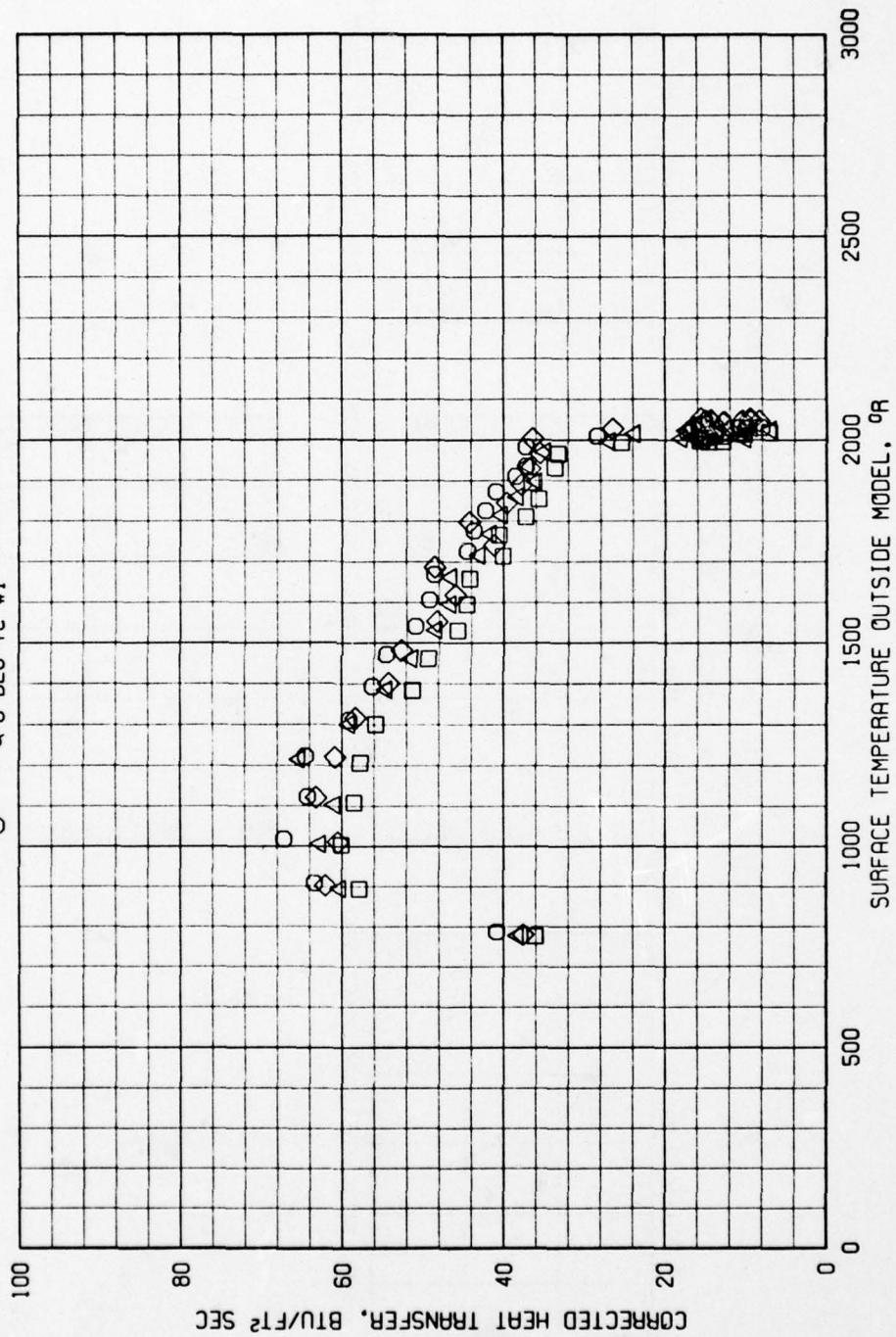


CORRECTED HEAT TRANSFER COEFF., BTU/FT² SEC OR

SURFACE TEMPERATURE OUTSIDE MODEL, OR

AD021 RUN 5 MODEL TI-15 DUST + WATER
 MODEL HEMI P0 = 500 T0 = 2030
 Time = 66.25 to 76.40 Sec

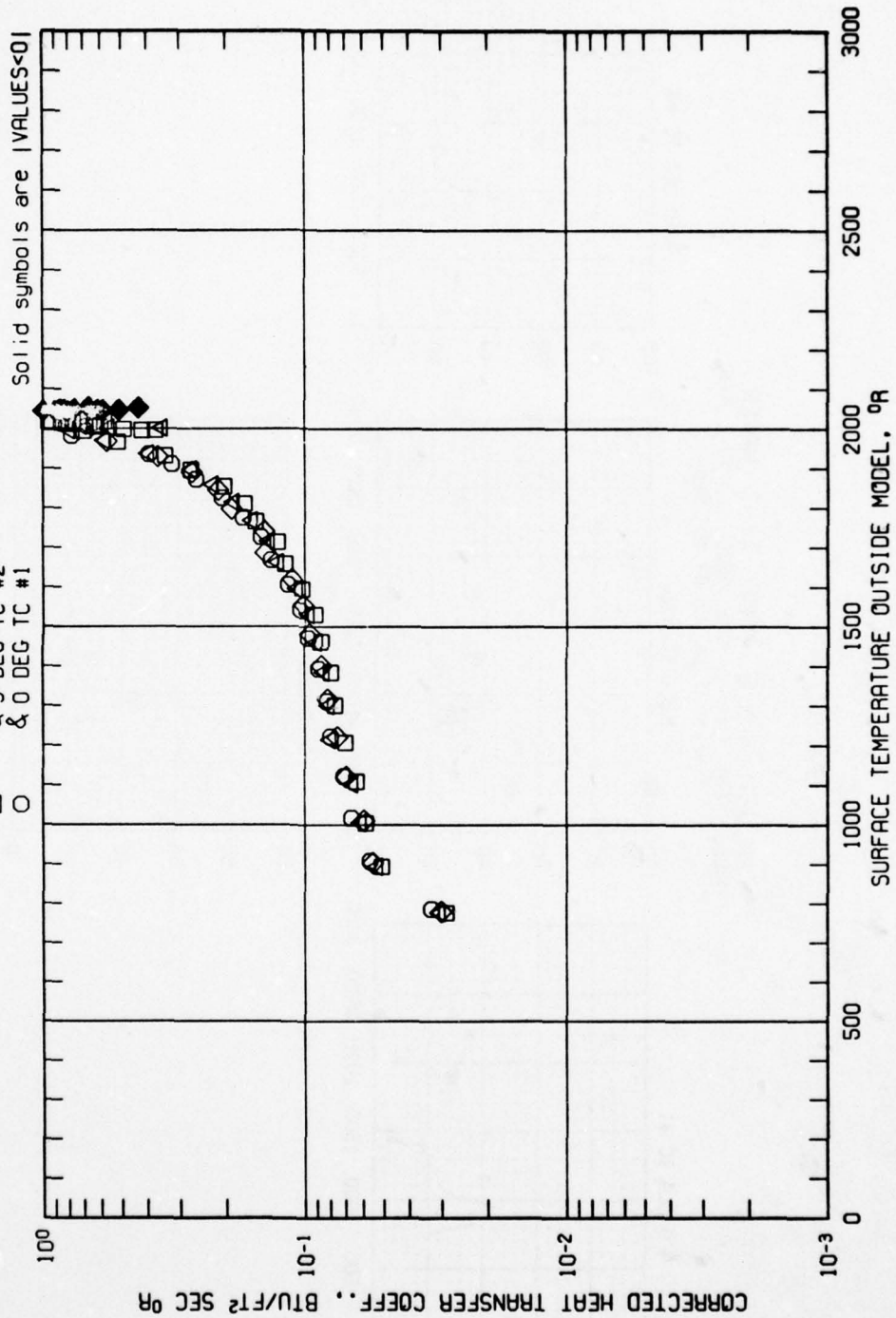
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 □ 10 DEG TC #3
 △ 5 DEG TC #2
 ○ 0 DEG TC #1



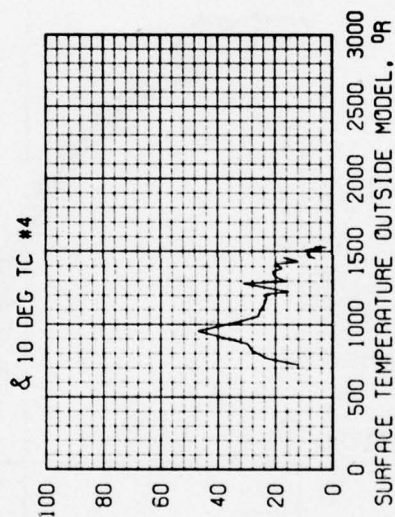
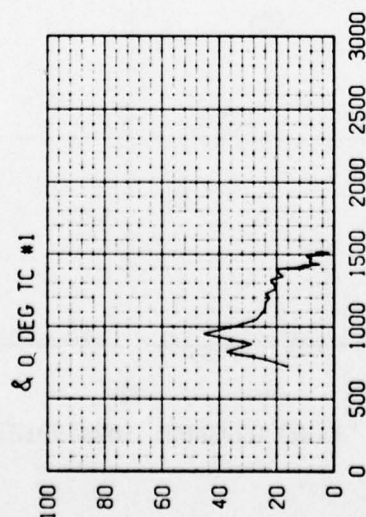
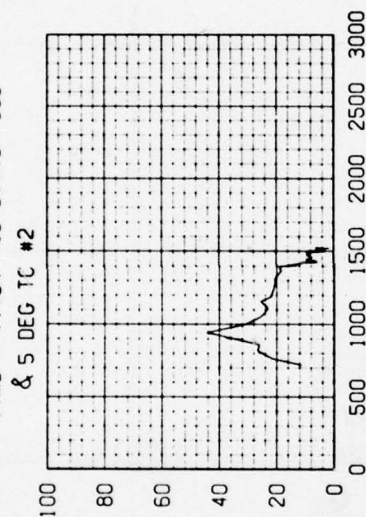
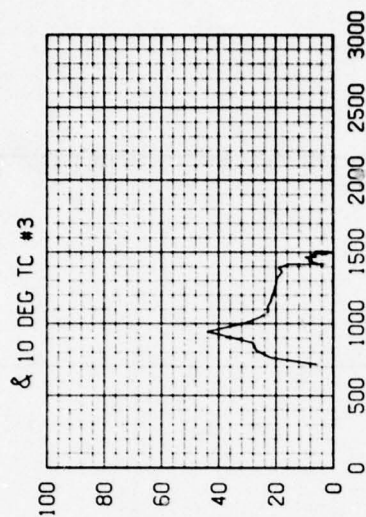
AD021 RUN 5 MODEL TI-15 DUST + WATER
 MODEL HEMI P0 = 500 T0 = 2030

Time = 66.25 to 76.40 Sec

◇ 10 DEG TC #4
 □ 10 DEG TC #3
 △ 5 DEG TC #2
 ○ 0 DEG TC #1



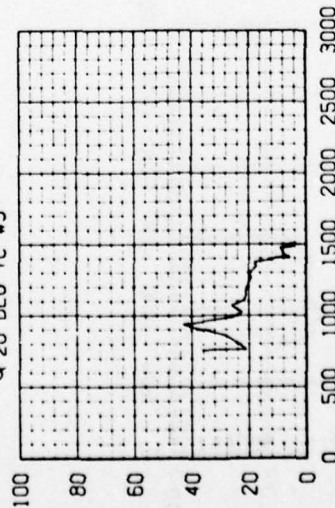
AD021 RUN 5 MODEL T1-7 WATER
 MODEL HEMI P0 = 500 T0 = 2030
 Time = 77.04 to 87.40 Sec



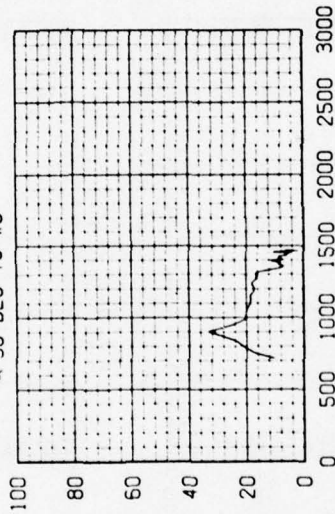
SURFACE TEMPERATURE OUTSIDE MODEL, °R

CORRECTED HEAT TRANSFER, BTU/FT² SEC

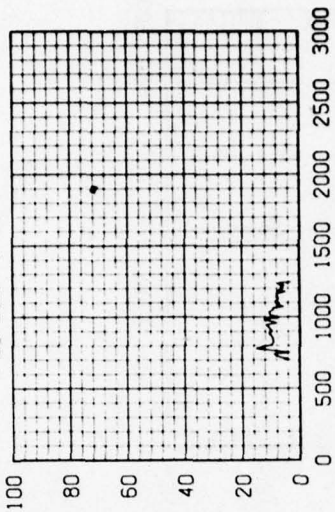
& 20 DEG TC #5



& 30 DEG TC #6



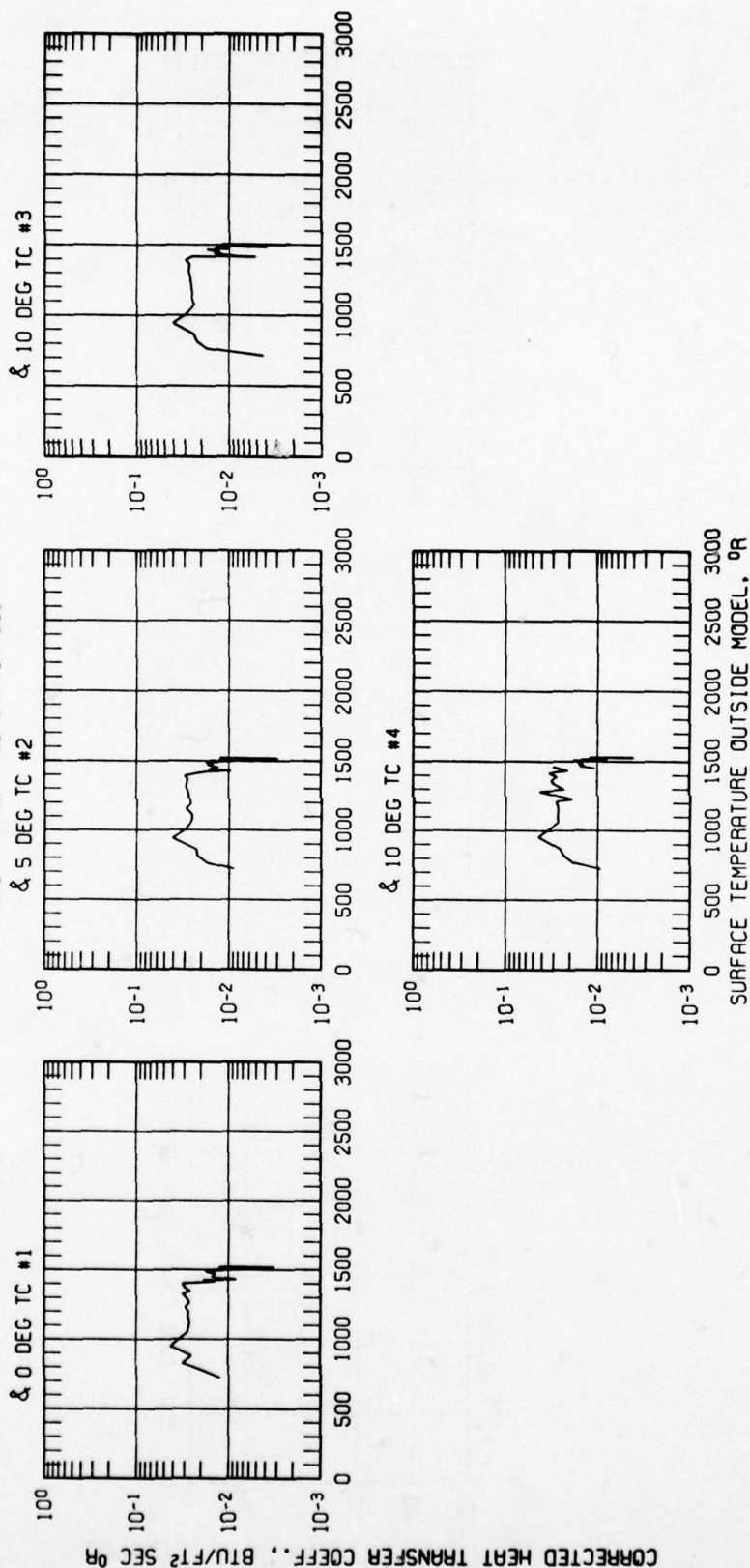
& 60 DEG TC #7



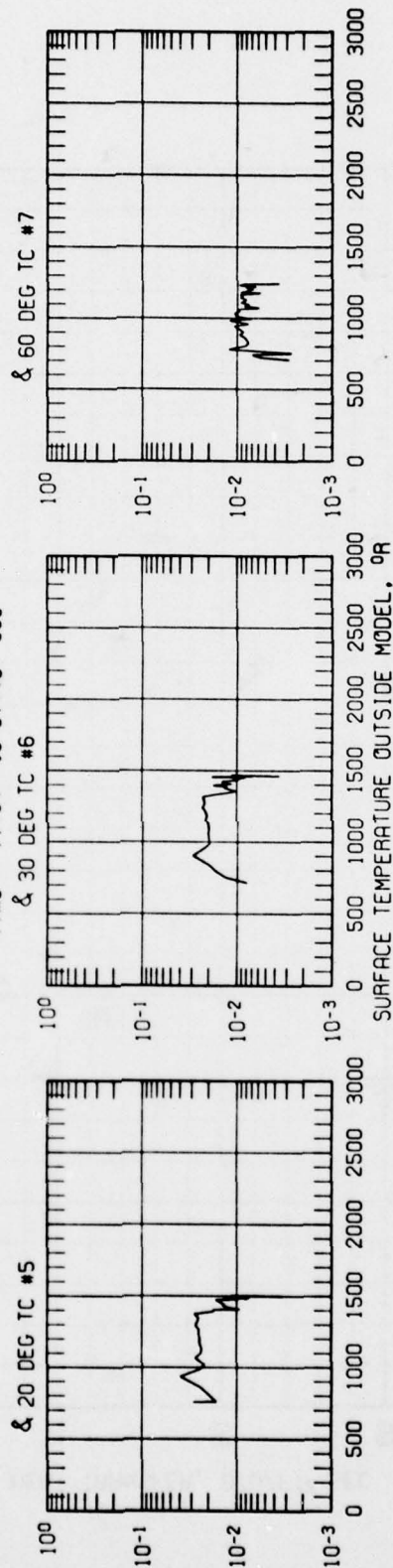
AD021 RUN 5 MODEL T1-7 WATER
 MODEL HEMI P0 = 500 T0 = 2030
 Time = 77.04 to 87.40 Sec

SURFACE TEMPERATURE OUTSIDE MODEL, °R

AD0021 RUN 5 MODEL T1-7 WATER
 MODEL HEMI P0 = 500 T0 = 2030
 Time = 77.04 to 87.40 Sec



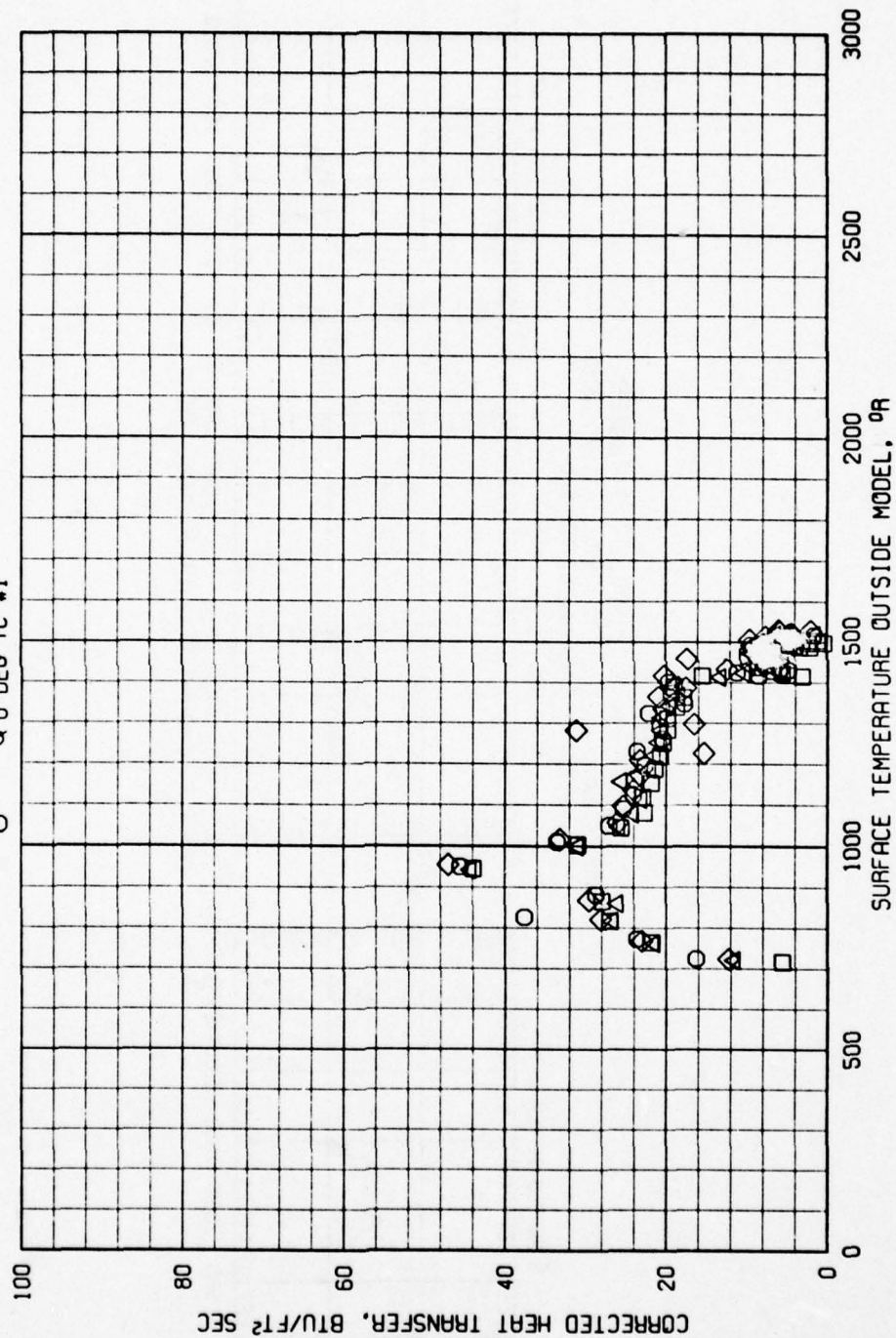
CORRECTED HEAT TRANSFER COEFF., BTU/FT² SEC °R



AD0021 RUN 5 MODEL T1-7 WATER
MODEL HEM1 PO = 500 TO = 2030
Time = 77.04 to 87.40 Sec

AD0021 RUN 5 MODEL TI-7 WATER
 MODEL HEMI PO = 500 TO = 2030
 Time = 77.04 to 87.40 Sec

◇ 10 DEG TC #4
 □ 10 DEG TC #3
 △ 5 DEG TC #2
 ○ 0 DEG TC #1



AD021 RUN 5 MODEL T1-7 WATER
 MODEL HEMI P0 = 500 T0 = 2030
 Time = 77.04 to 87.40 Sec

◇ & 10 DEG TC #4
 □ & 10 DEG TC #3
 △ & 5 DEG TC #2
 ○ & 0 DEG TC #1

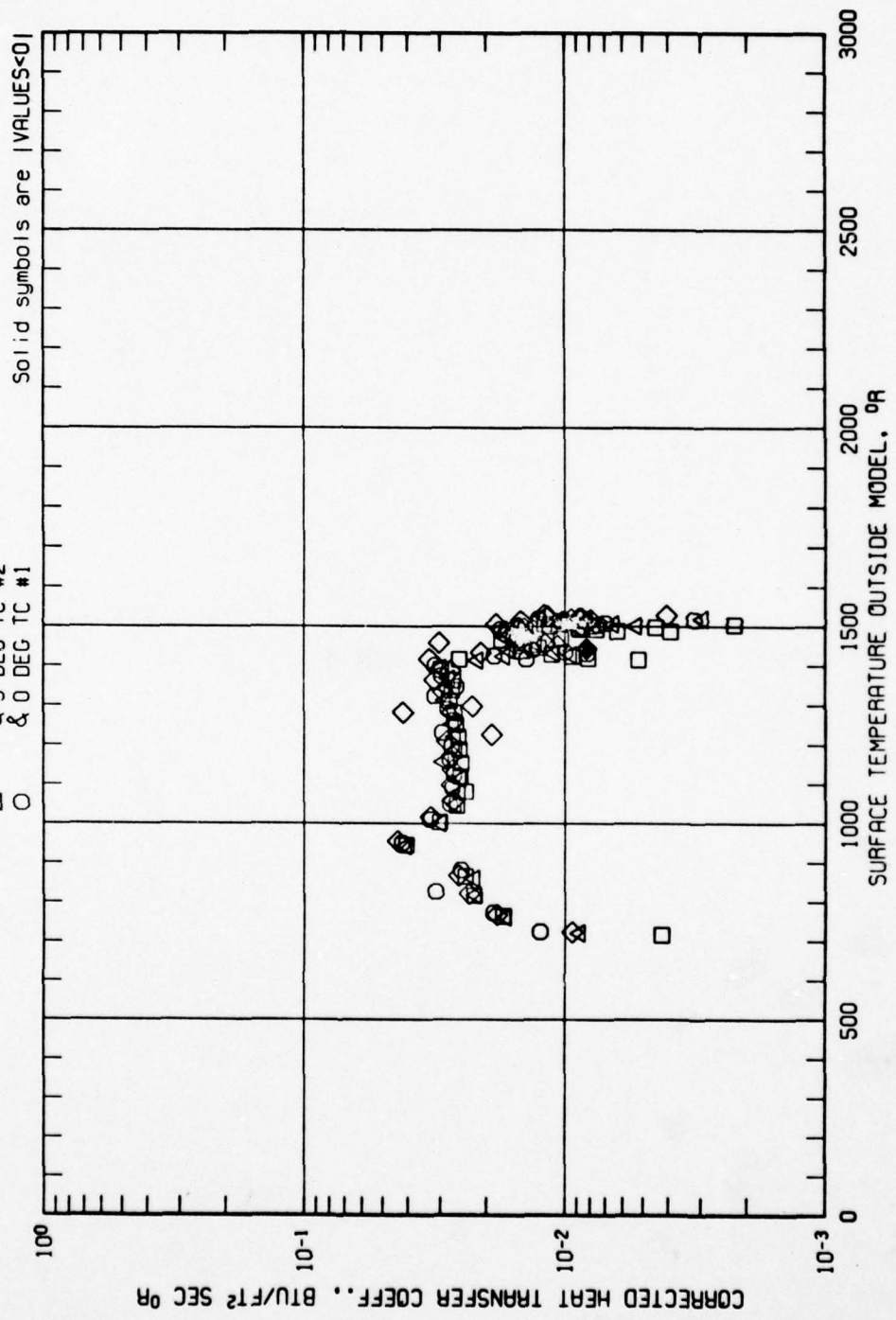


TABLE 1 RUN SUMMARY

RUN 6 DATE 1-12-77

WATER

DUST

TYPE

SIZE

VEL

Flow

C.F.

MgO

100

4560

7.92

23.4

0.39

42.2

0.020

Flow

C.F.

gpm

in.

psi

23.4

0.39

42.2

0.020

930

psi

23.4

0.39

42.2

0.020

930

psi

23.4

MODEL CONDITIONS

Po = 994 psia, P_{Om} = 996

H_{0g} = 756 3tu/lbm, H_{Om} = 724

W₀ = 780 3tu/lbm

T_{0g} = 2860 °R, T₀ = 2924 °R

V = 7.1 Po' = 9.43 psia

S N	MODEL NUMBER	EXPOSURE TIME				MODEL DESCRIPTION				MODEL INSTRUMENTATION					PHOTOGRAPHS	
		PH	DUST	H ₂ O	DUST & H ₂ O	POH	GEOMETRY	DIAM, In.	MATERIAL	T/C TYPE	NO. OF T/C's	PR. TAP	NO. OF TAPS	TRANSDUCER TYPE	PRERUN	POSTRUN
1	Po probe	3					See Fig. 3	1.0	SS			x	1	Strain Gage		
2	T ₀ probe	20					See Fig. 3	0.25		R	1					
3	T _i -12	4.19					Hemi	2.0	6A1-4V- T _i	S	8				102	241
4	WB-4S WB-4A	3.82					See Fig. 2	0.5	SS Al							239
5	T _i -13	0.76	3.78				Hemi	2.0	6A1-4V- T _i	S	8				6837	240
6	T _i -11		2.11 2.40	0 2.40	- x		Hemi	2.0	6A1-4V- T _i	S	8				8005	242
7	T _i -2	1.47		2.49			Hemi	2.0	6A1-4V- T _i	S	8				8031	237
8	WB-3S WB-3A			3.78			See Fig. 2	0.5	SS Al							238
9	GS			20			See Fig. 4	2.0	SS							604 605
10																

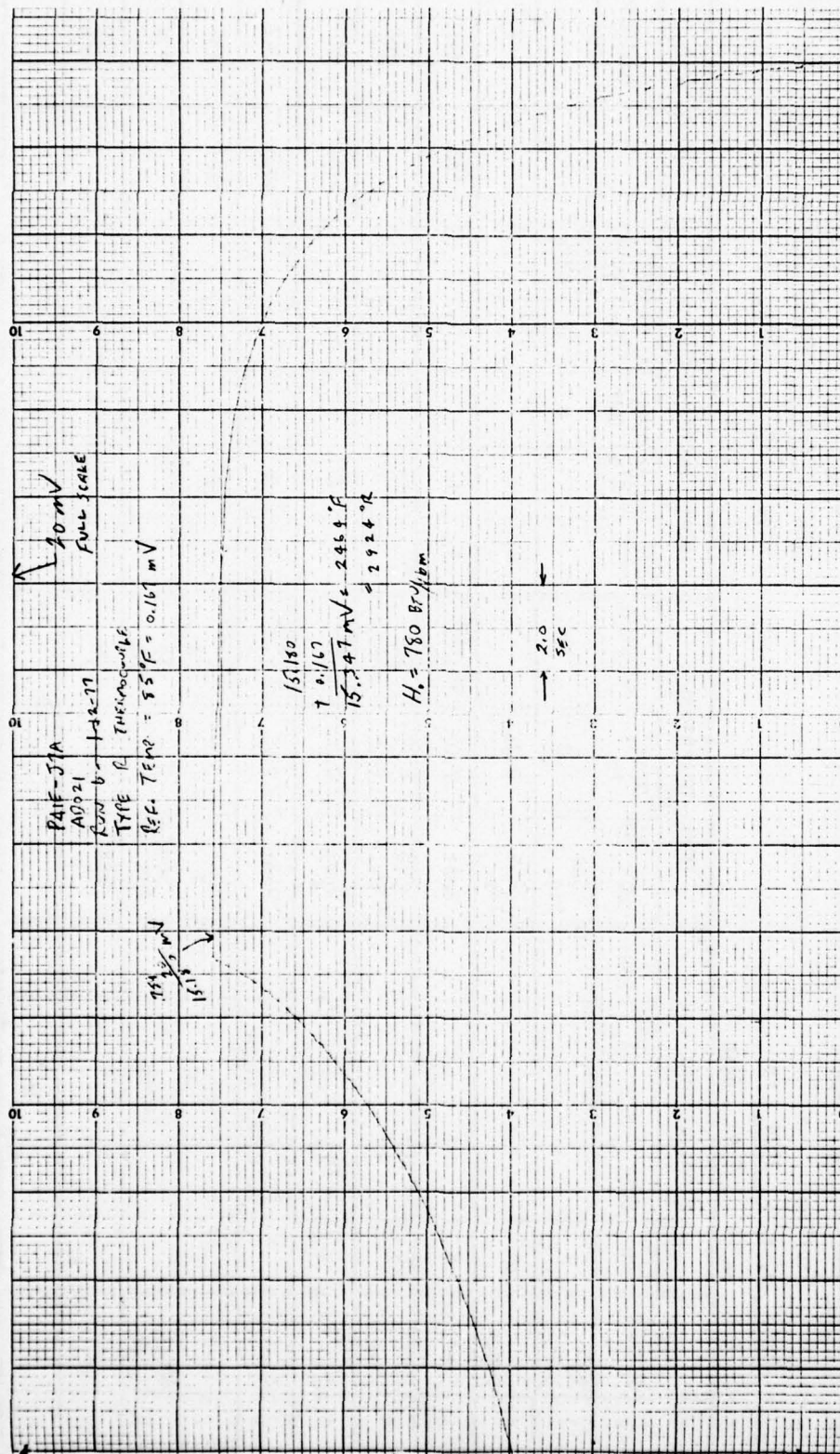
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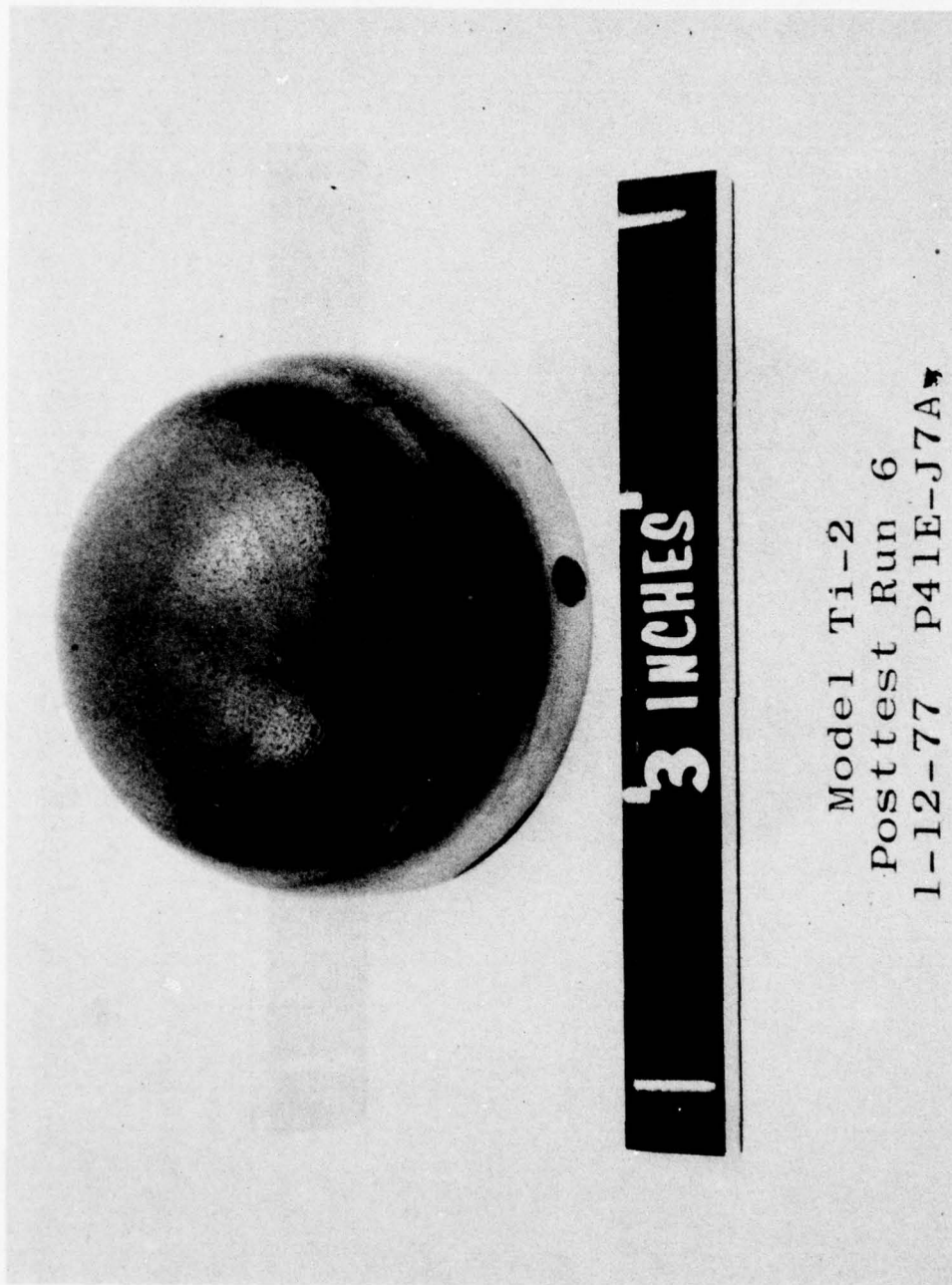
KEY -

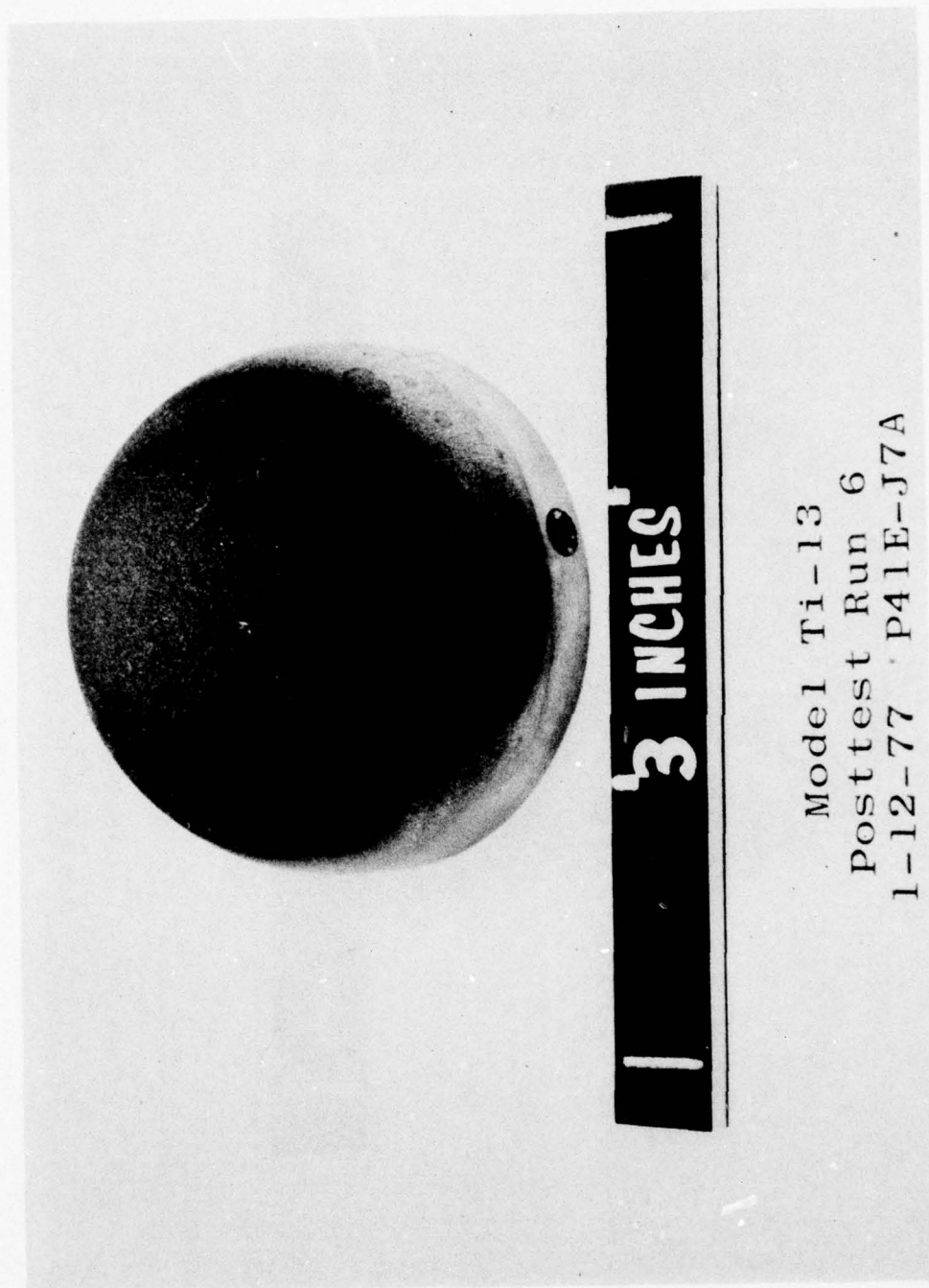
PH - PREHEAT

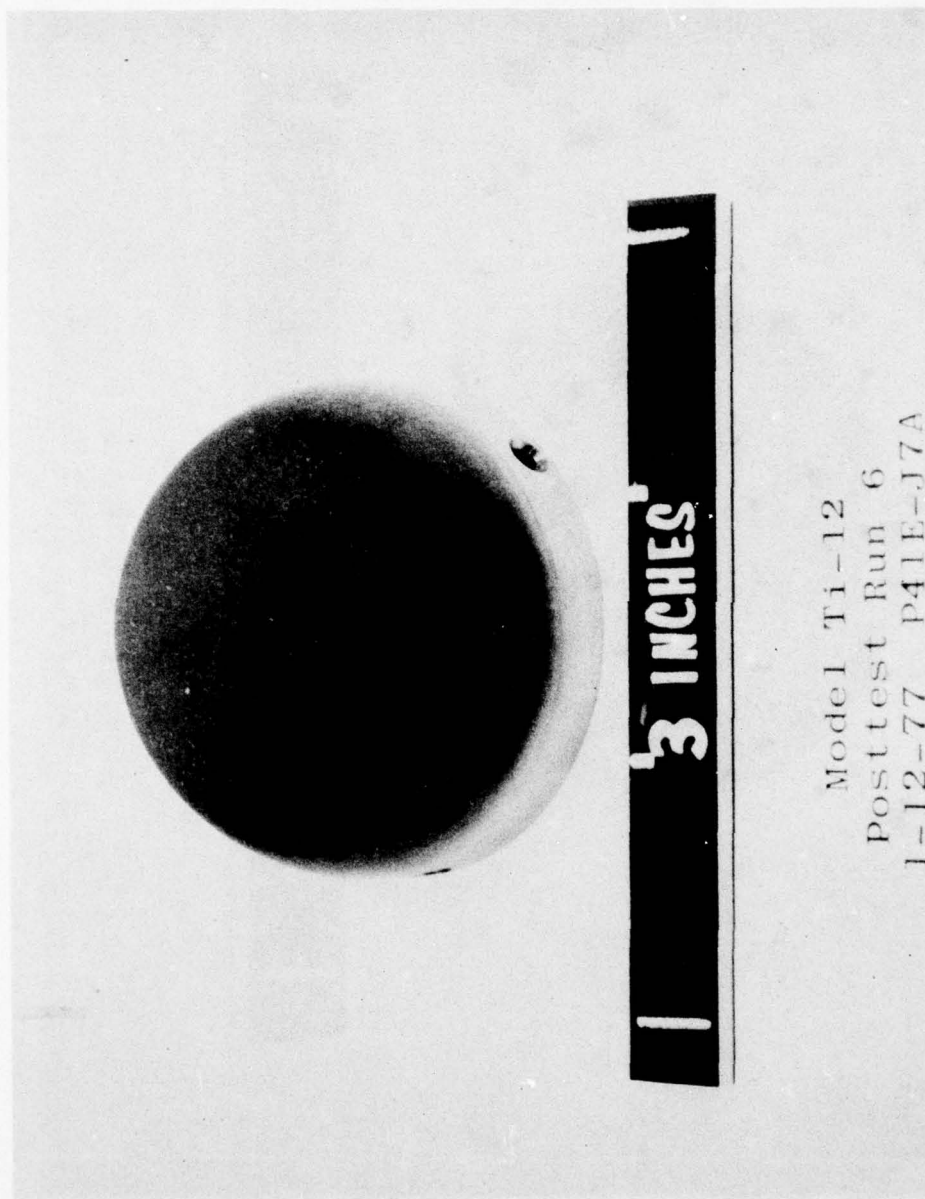
POH - POSTHEAT

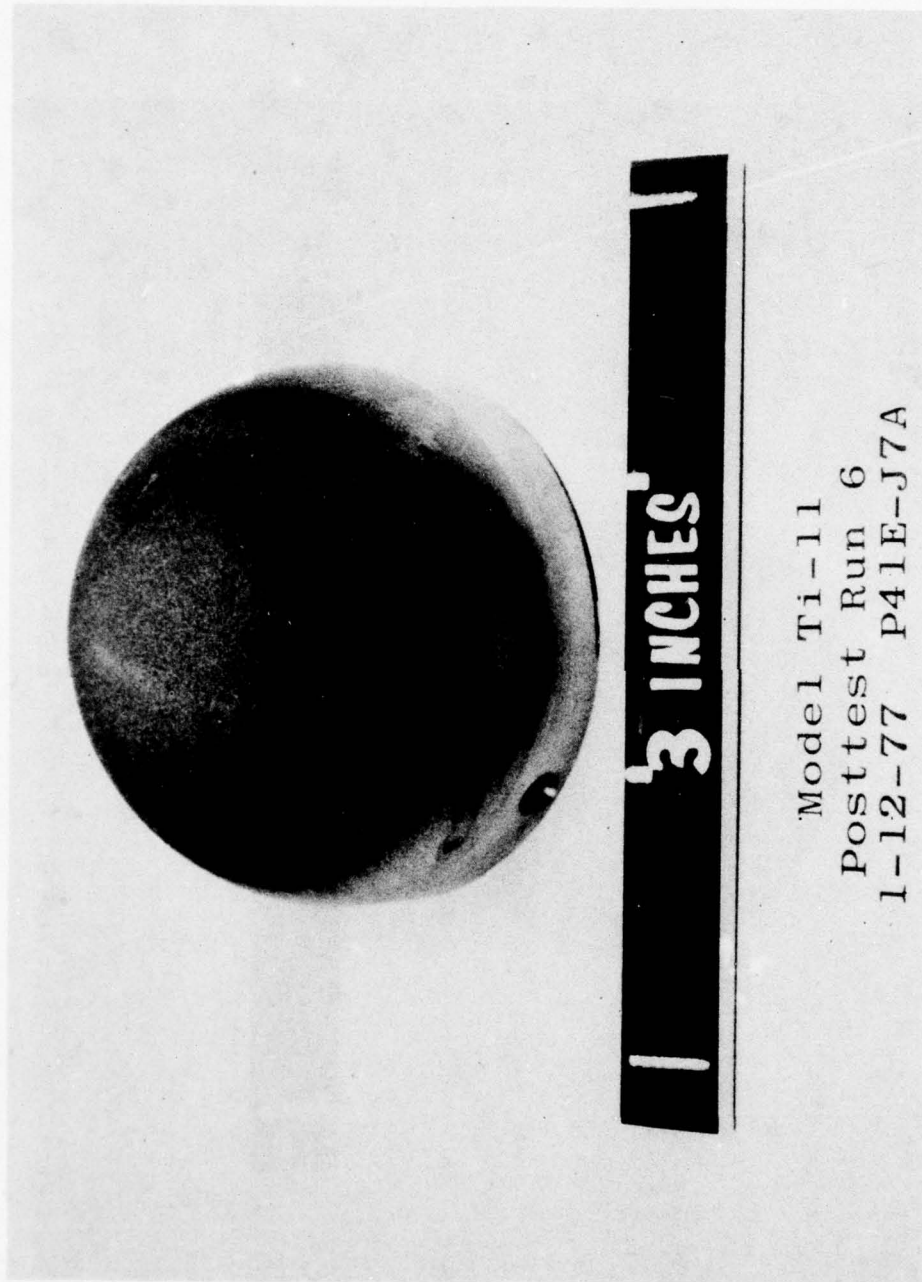
DUST AND H₂O - IF CHECKED, MEANS DUST AND WATER FLOWING AT SAME TIME

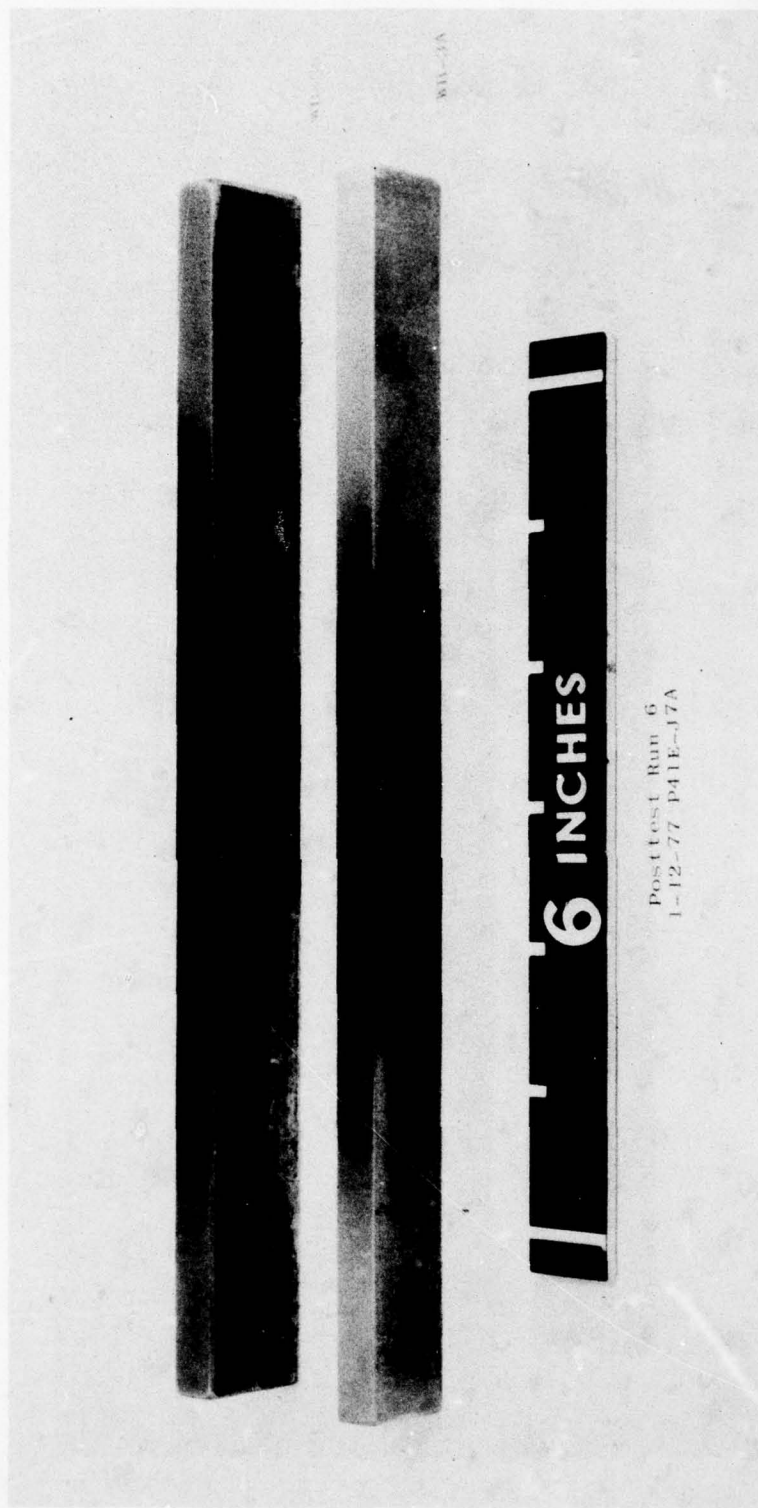


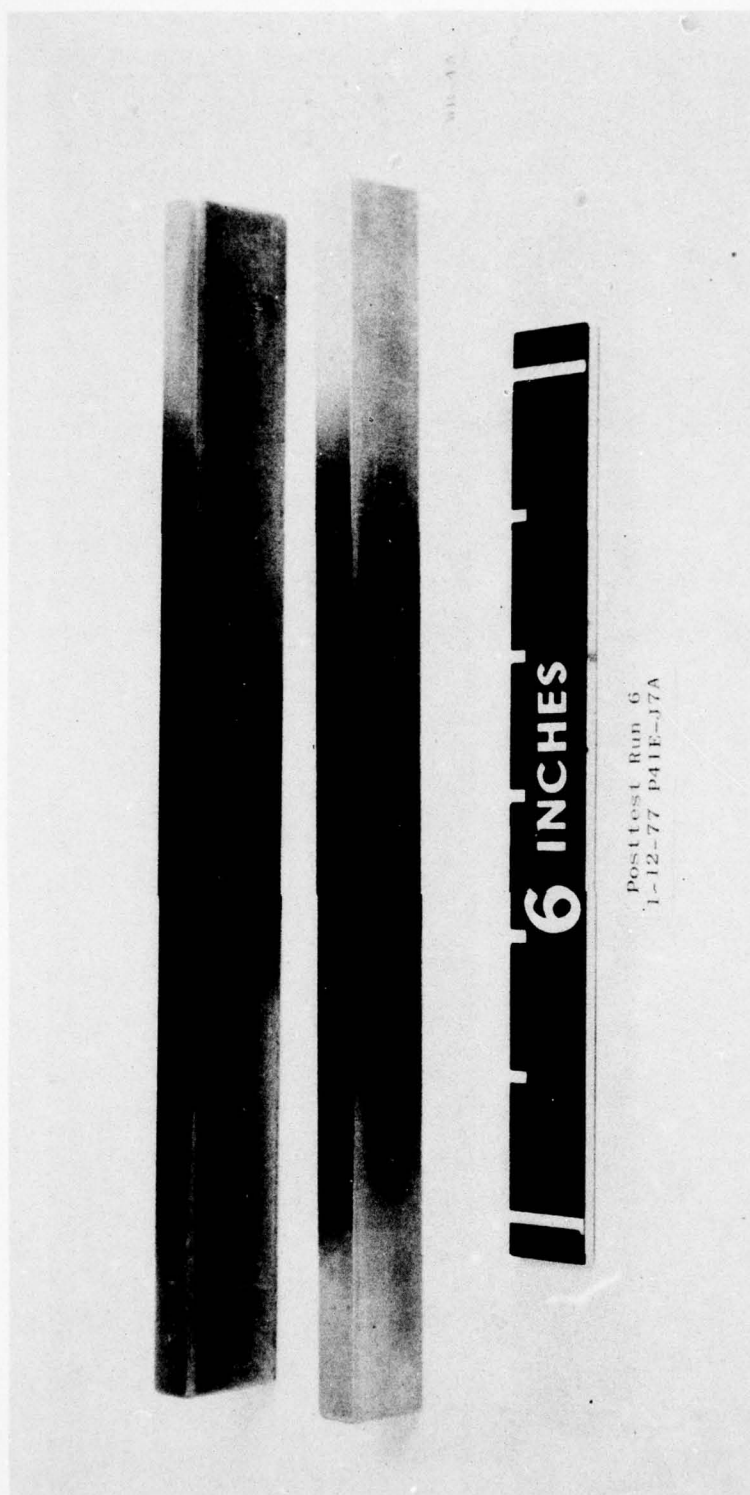








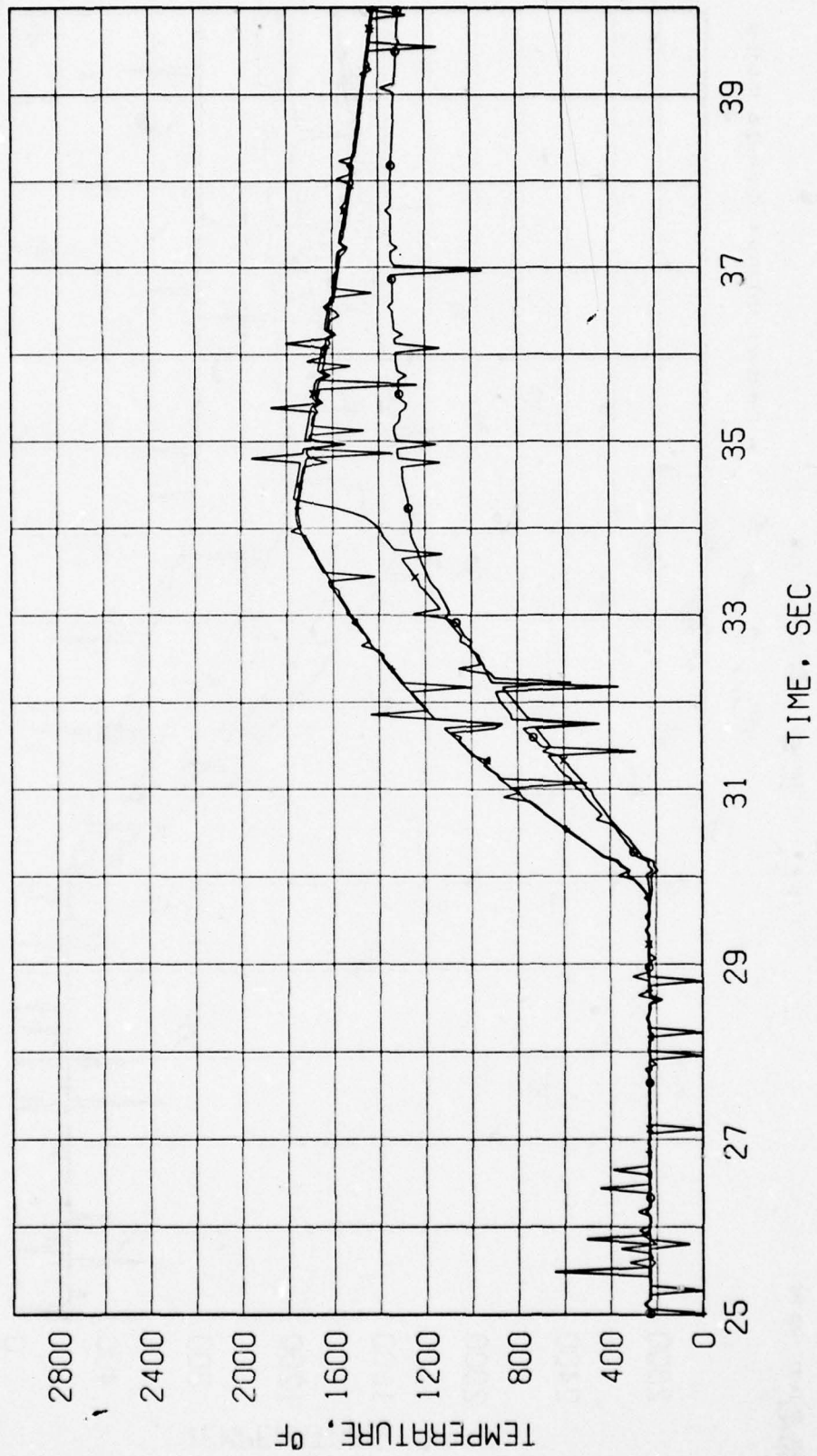




DATE 01-14-77 PRO INC
PROJ-PAIE

PROJECT PAIE TEST #0021 DATE 01-12-77 SEL 2106

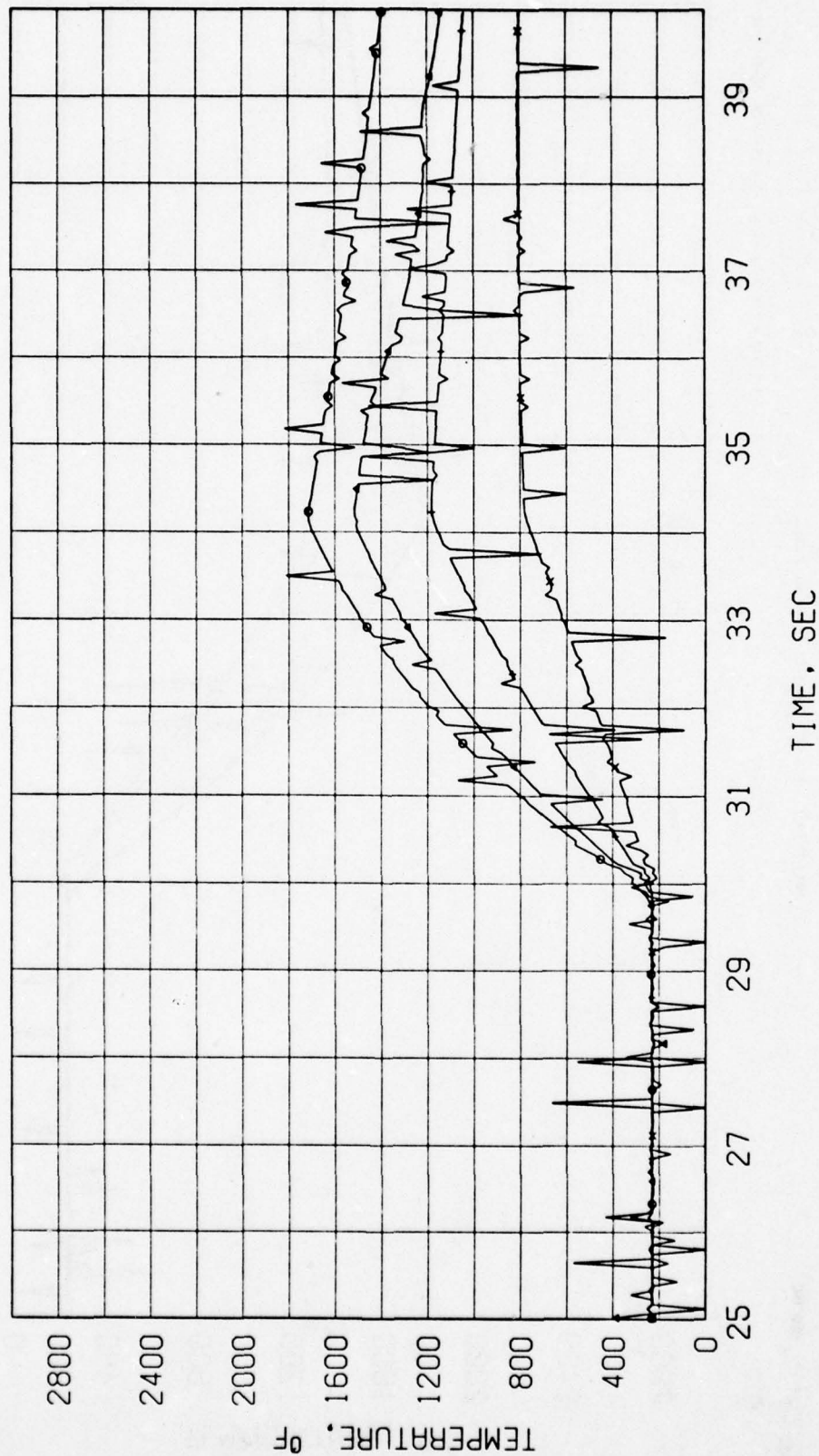
X TC-4-TI-12 + TC-3-TI-12 Δ TC-2-TI-12 ○ TC-1-TI-12



DATE 01-14-77 ARD INC
PROJ-P41E

PROJECT P41E TEST R0021 DATE 01-12-77 SEL 2106

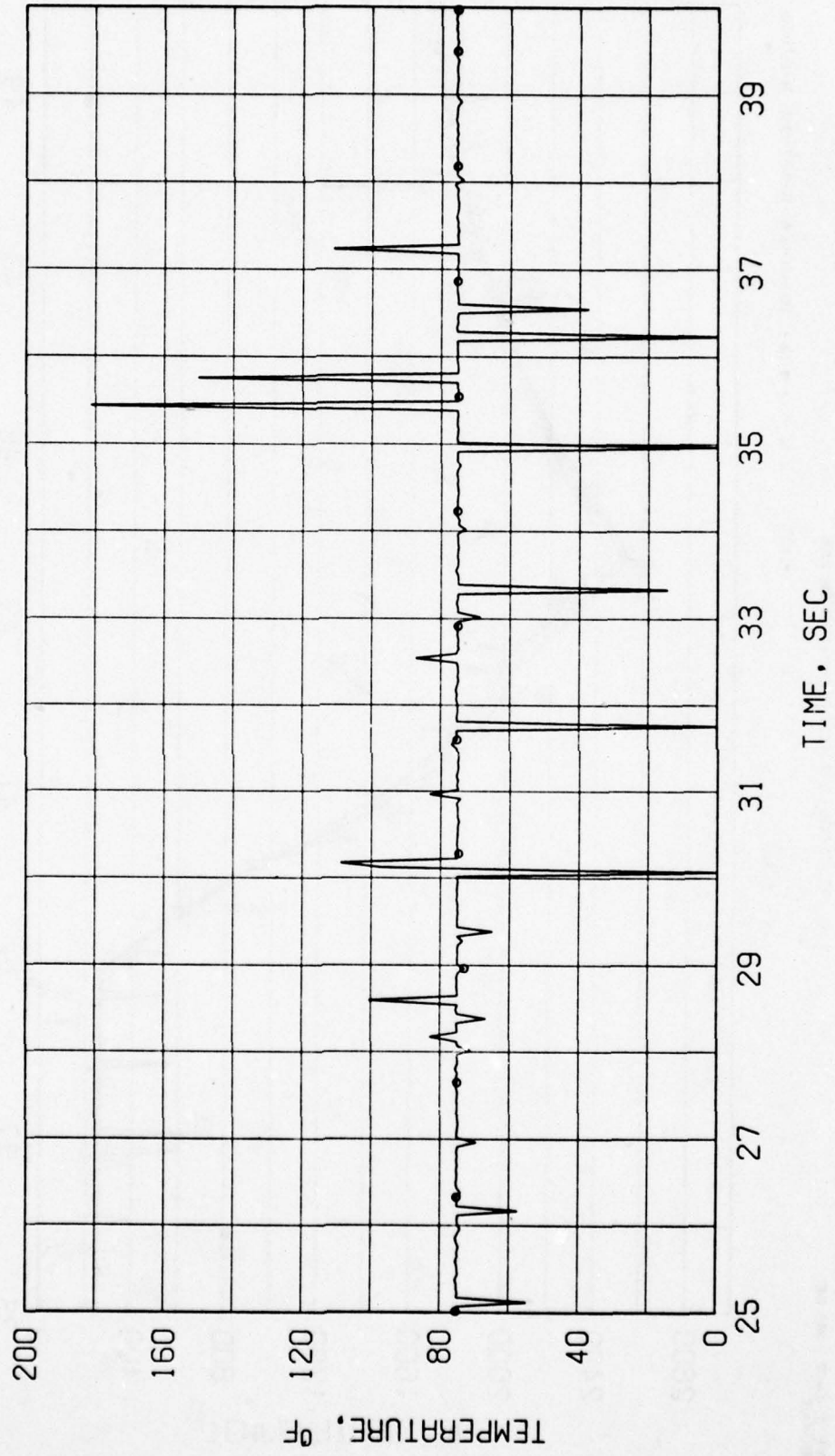
X TC-8-T1-12 + TC-7-T1-12 ▲ TC-6-T1-12 ○ TC-5-T1-12



DATE 01-14-77 RRD INC
PROJ-P41E

PROJECT P41E TEST R0021 DATE 01-12-77 SEL 2106

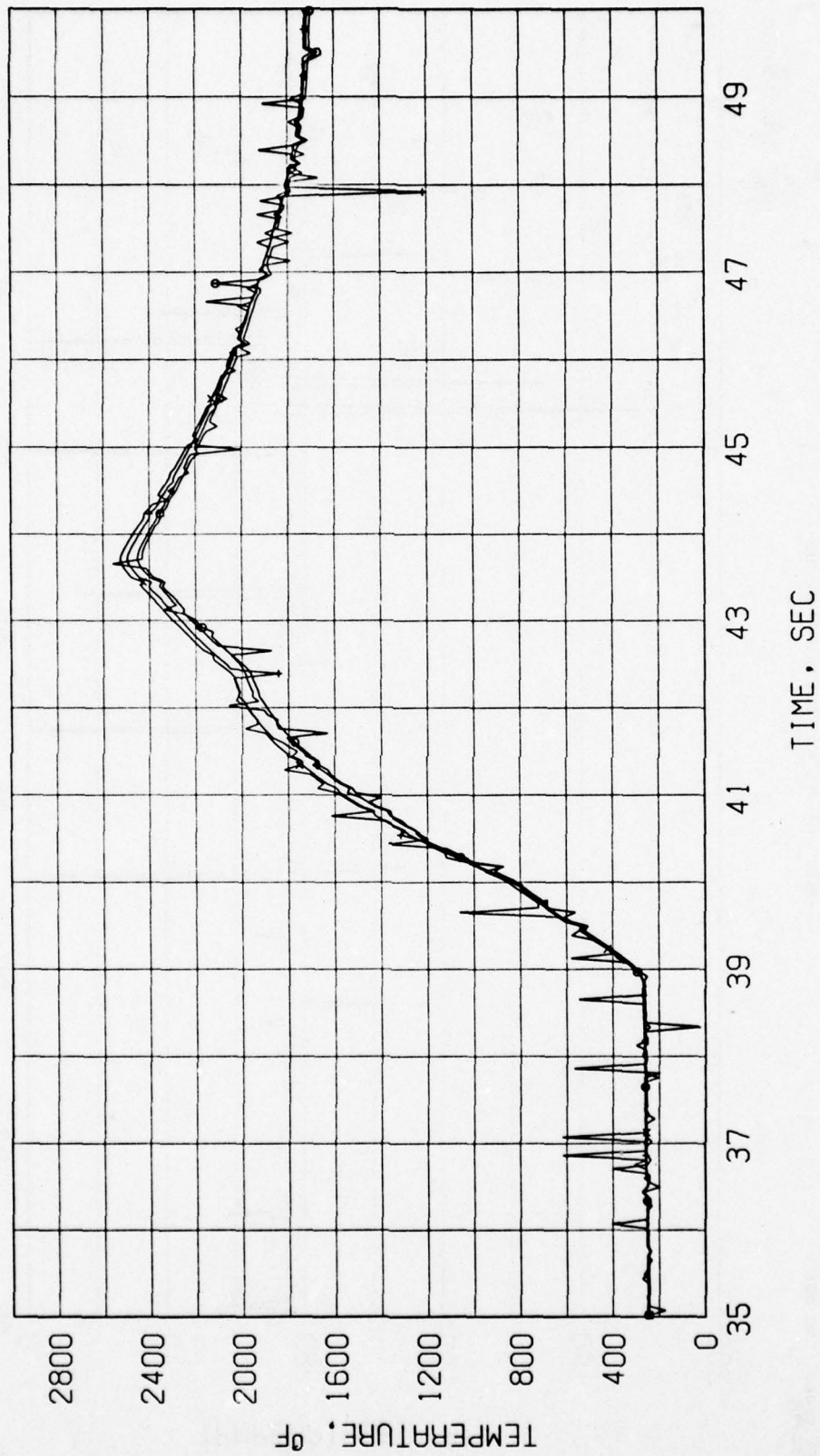
TC-9-T1-12



DATE 01-14-77 PRO INC
PROJ-P41E

PROJECT P41E TEST R0021 DATE 01-12-77 SEL 2106

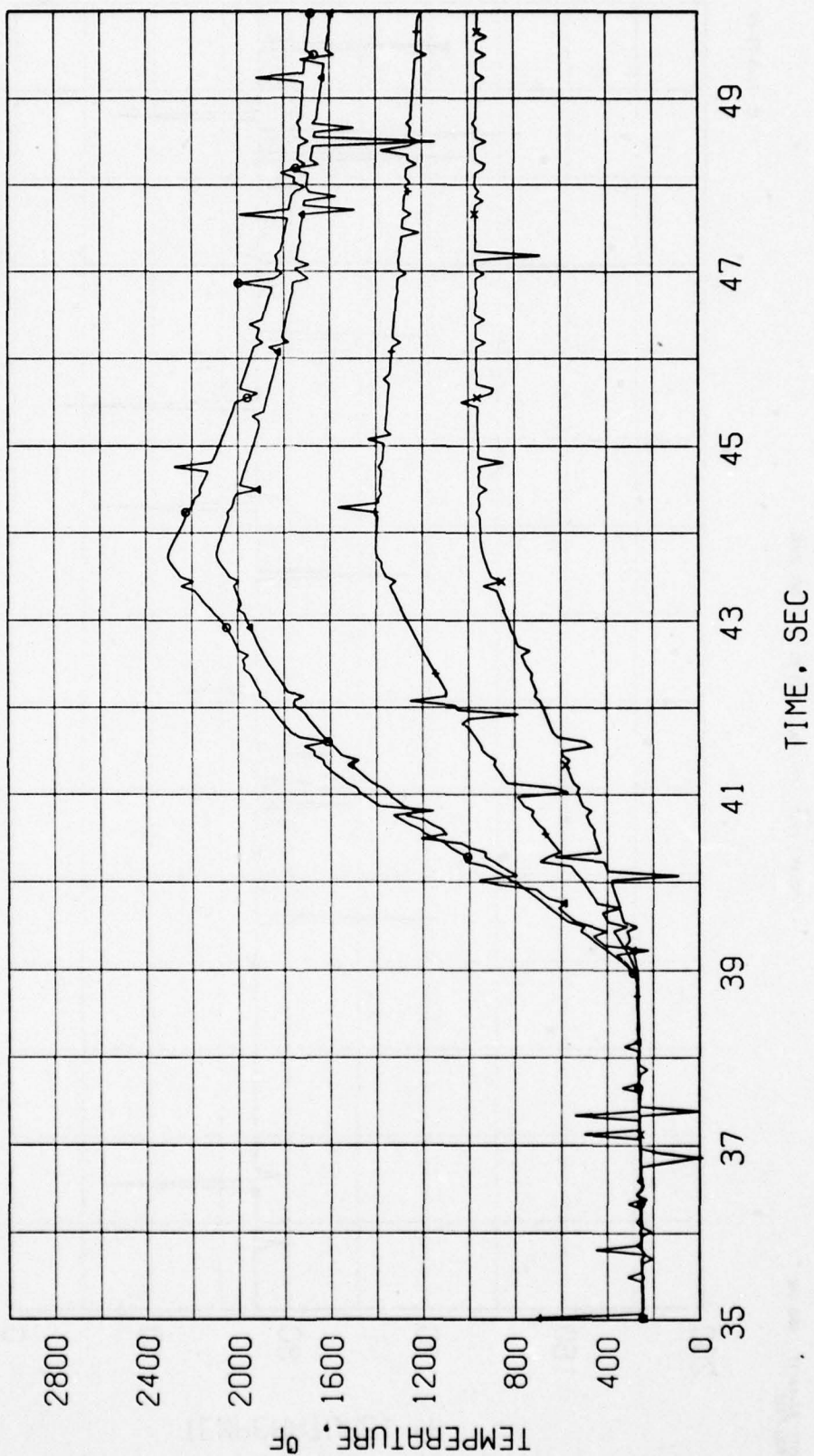
X TC-4-TI-13 + TC-3-TI-13 ▲ TC-2-TI-13 ○ TC-1-TI-13



DATE 01-14-77 PRO INC
PROJ-PAIE

PROJECT PAIE TEST R0021 DATE 01-12-77 SEL 2106

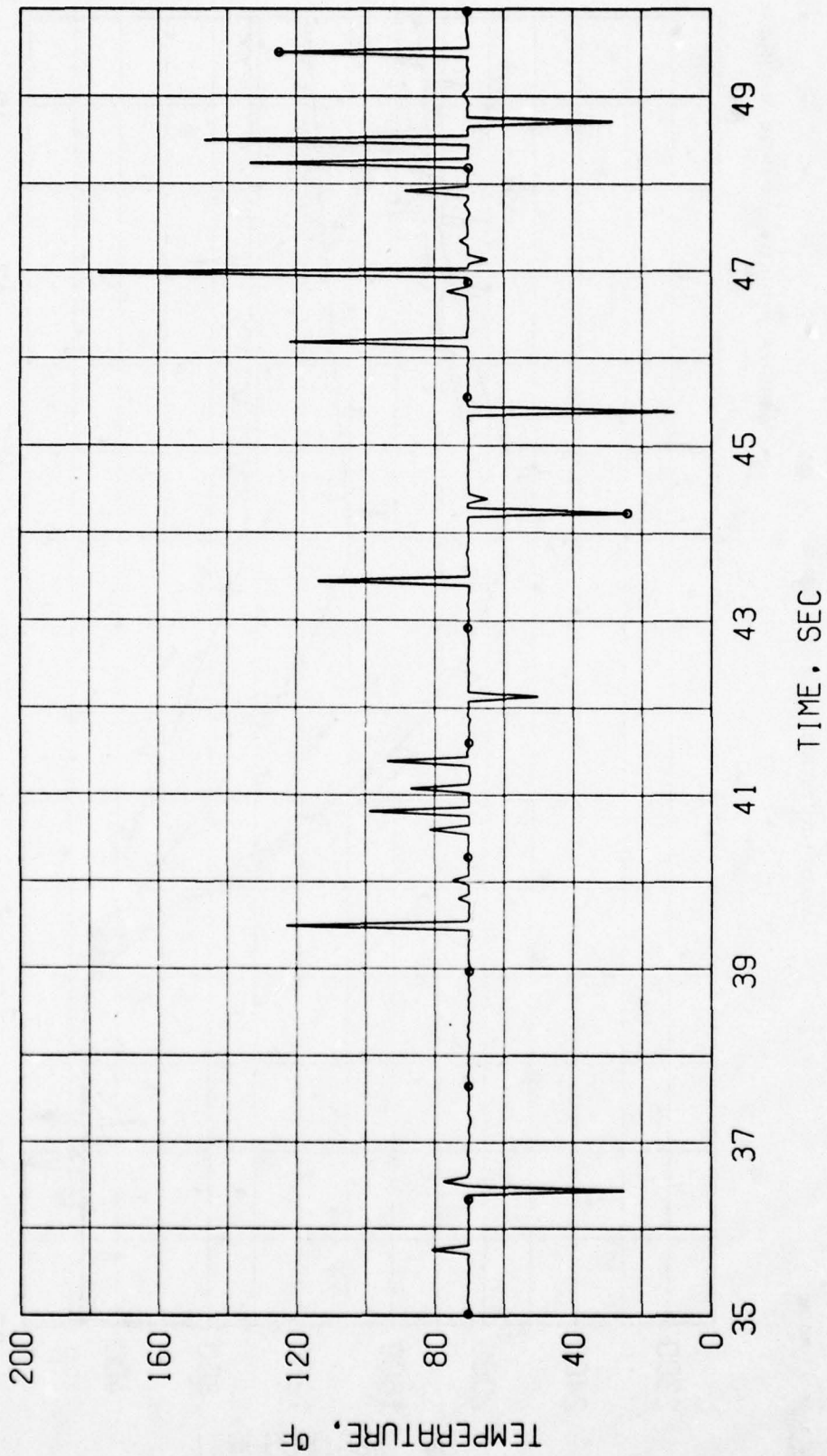
X TC-8-TI-13 + TC-7-TI-13 Δ TC-6-TI-13 ○ TC-5-TI-13



DATE 01-14-77 RMO INC
PROJ-P41E

PROJECT P41E TEST R0021 DATE 01-12-77 SEL 2106

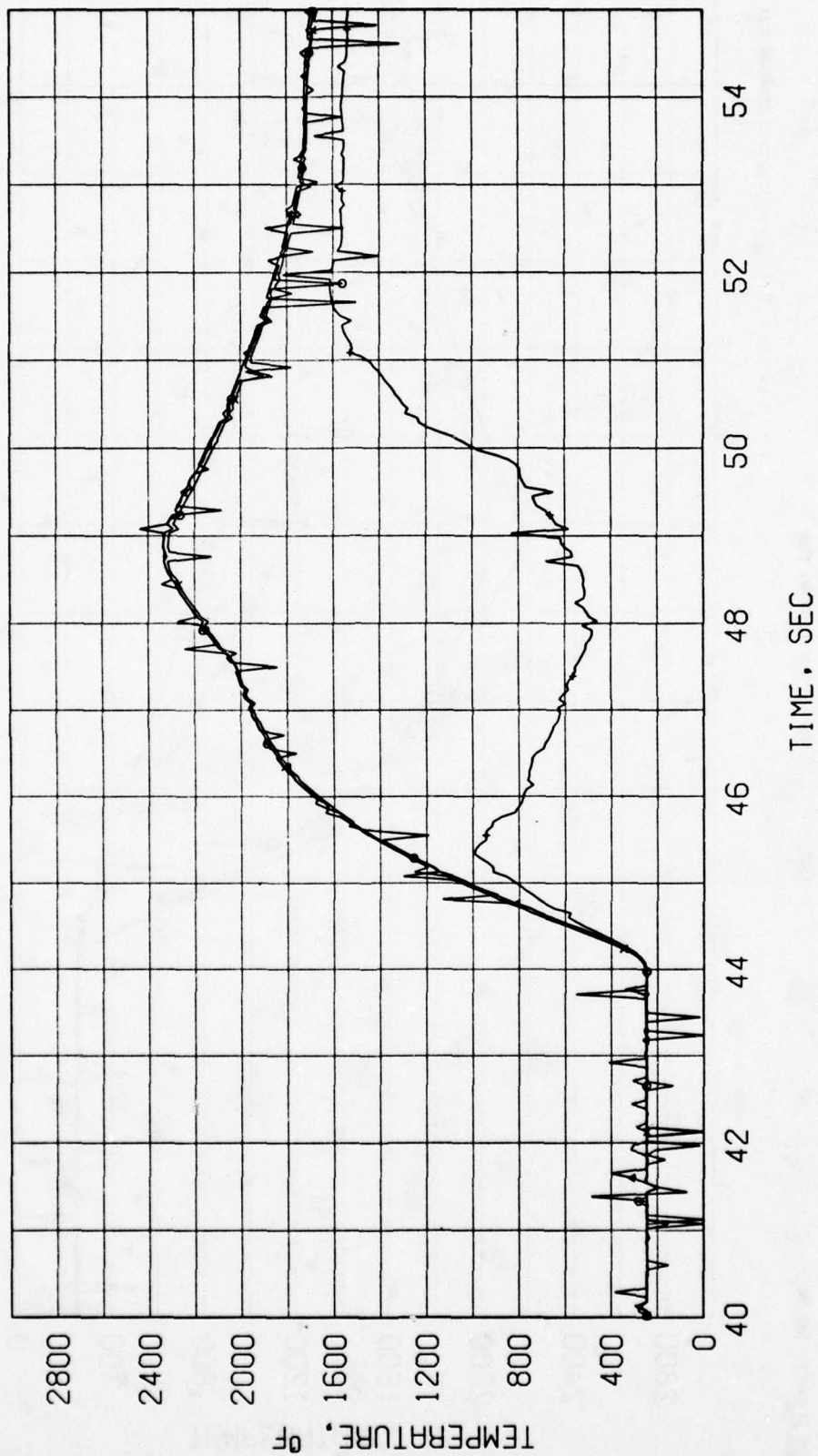
TC-9-TI-13



DATE 01-14-77 RRO INC
PROJ-P41E

PROJECT P41E TEST R0021 DATE 01-12-77 SEL 2106

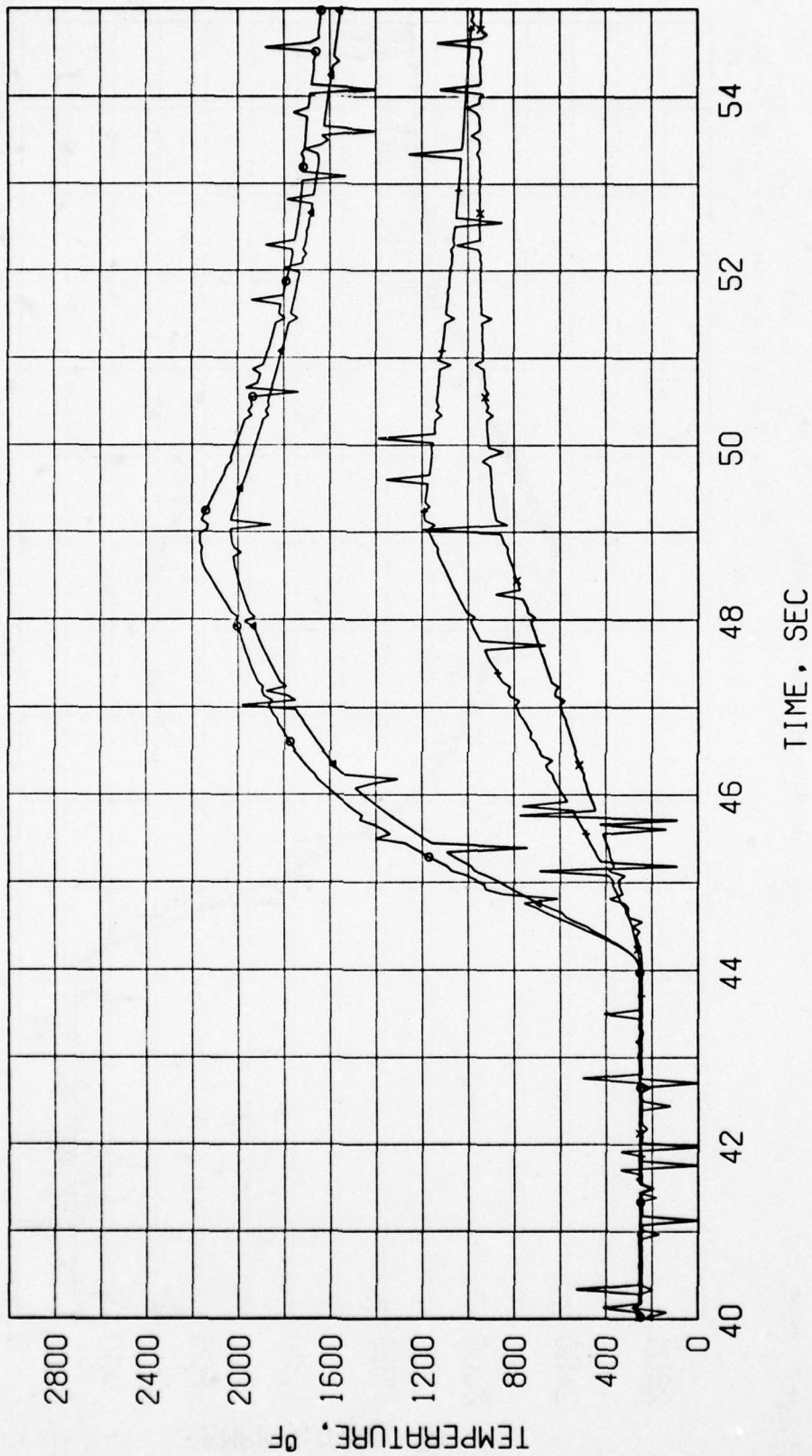
X TC-4-T1-11 + TC-3-T1-11 ▲ TC-2-T1-11 ○ TC-1-T1-11



DATE 01-14-77 RMO INC
PROJ-P41E

PROJECT P41E TEST R0021 DATE 01-12-77 SEL 2106

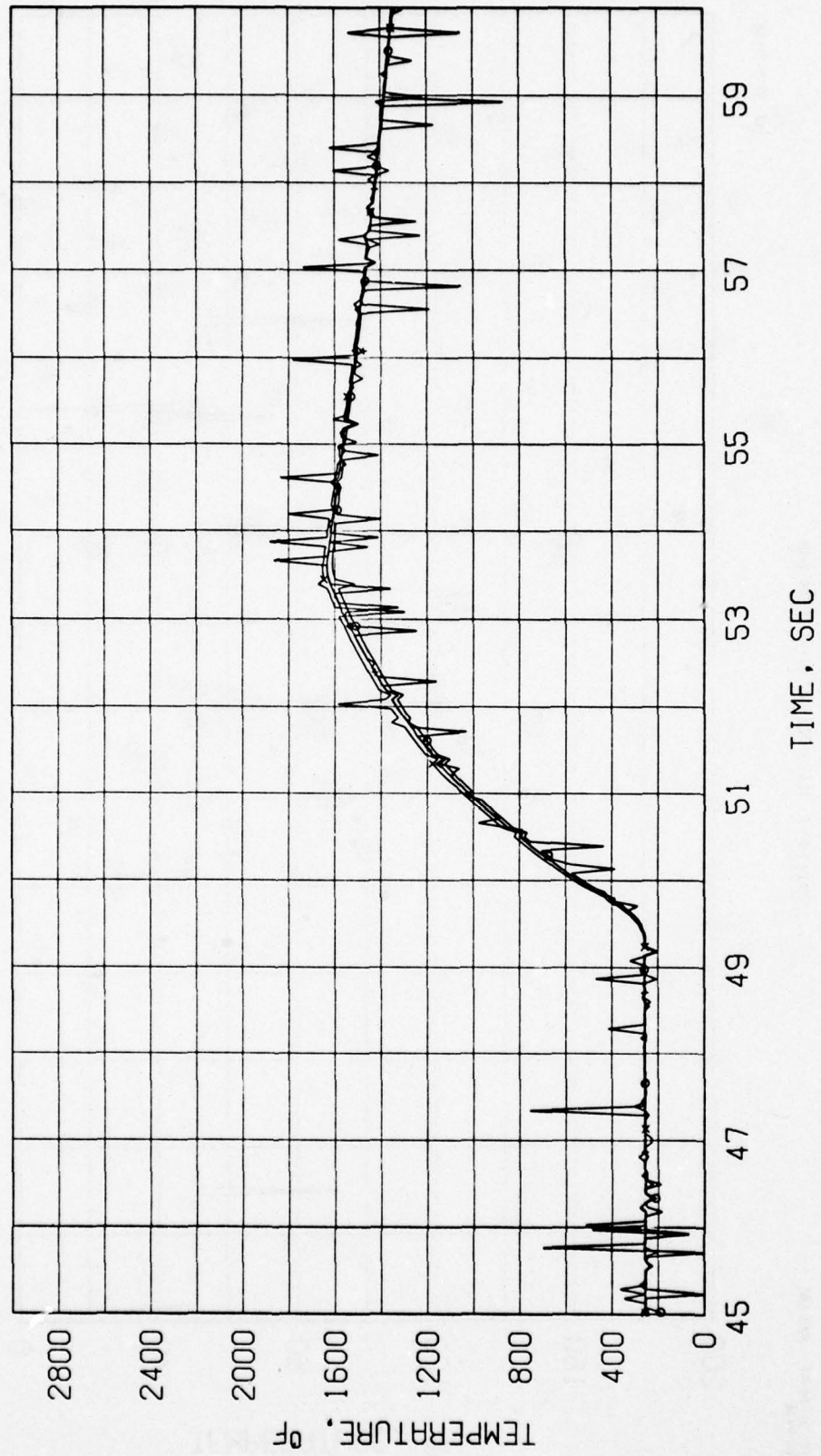
X TC-8-T1-11 + TC-7-T1-11 ▲ TC-6-T1-11 ○ TC-5-T1-11



DATE 01-14-77 ARO INC
PROJ-P41E

PROJECT P41E TEST R0021 DATE 01-12-77 SEL 2106

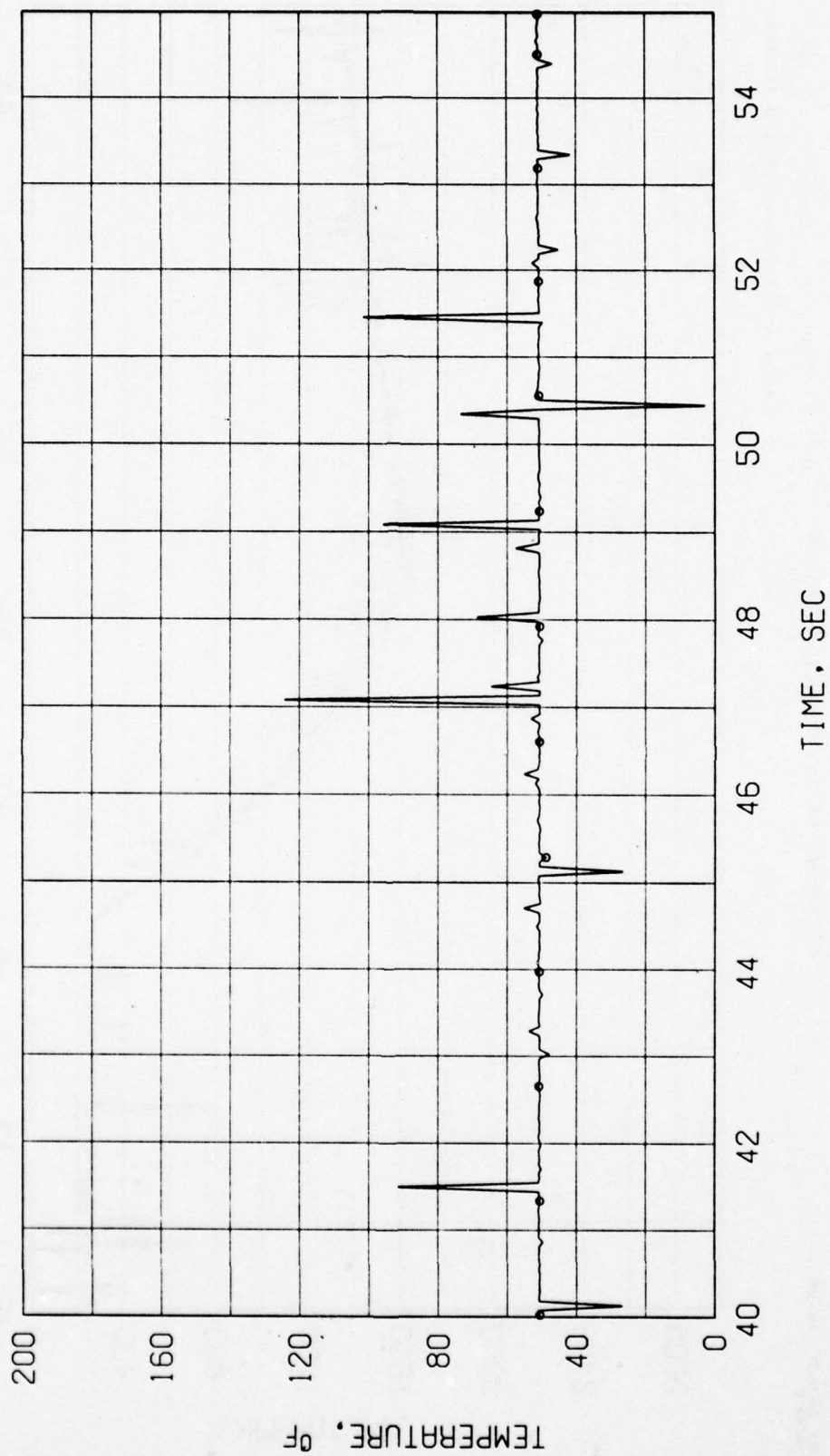
X TC-4-T1-2 + TC-3-T1-2 ▲ TC-2-T1-2 ○ TC-1-T1-2



DATE 01-14-77 ARO INC
PROJ-P41E

PROJECT P41E TEST R0021 DATE 01-12-77 SEL 2106

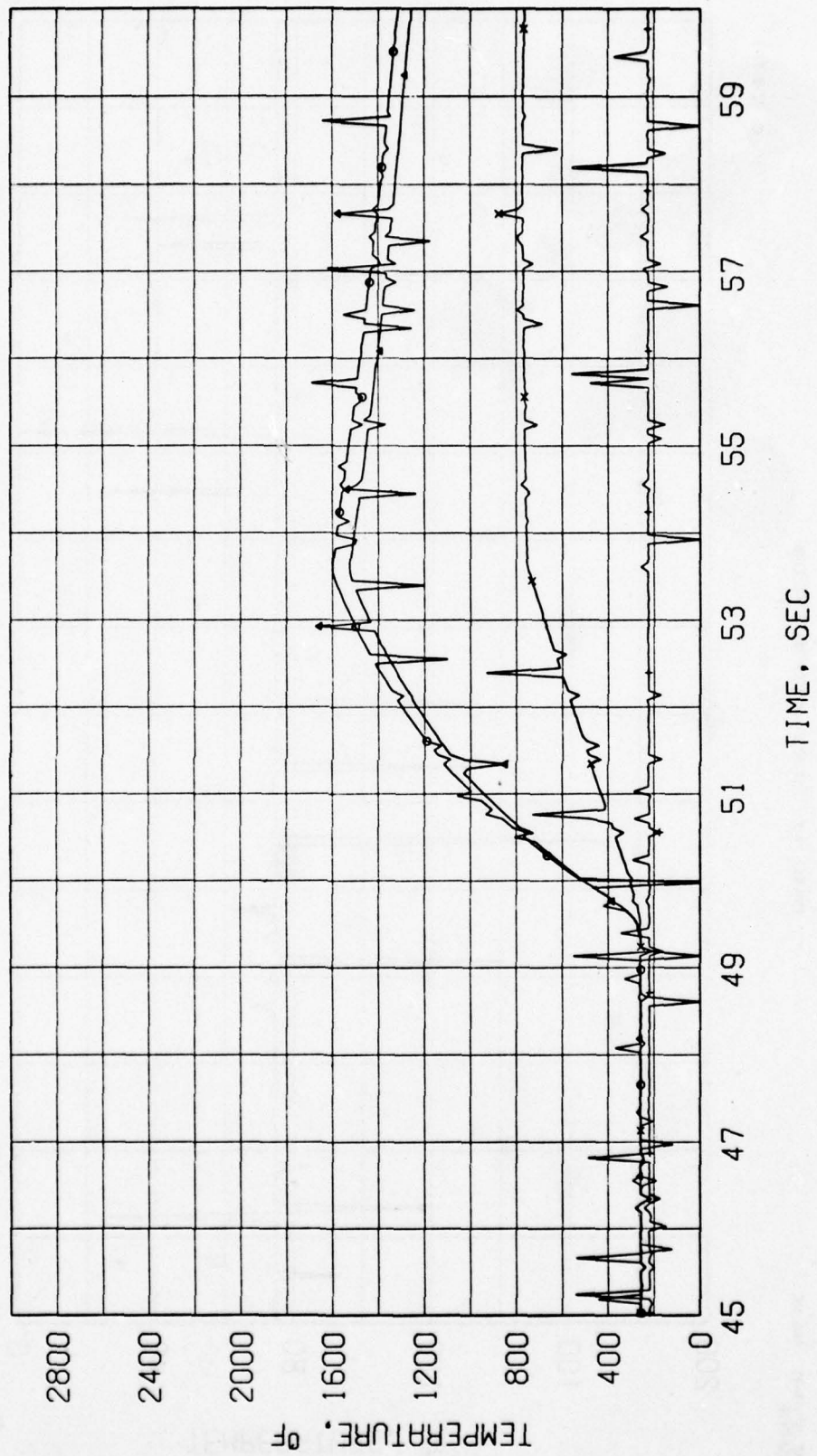
TC-9-TI-11



DATE 01-14-77 RRD INC
PROJ-P41E

PROJECT P41E TEST R0021 DATE 01-12-77 SEL 2106

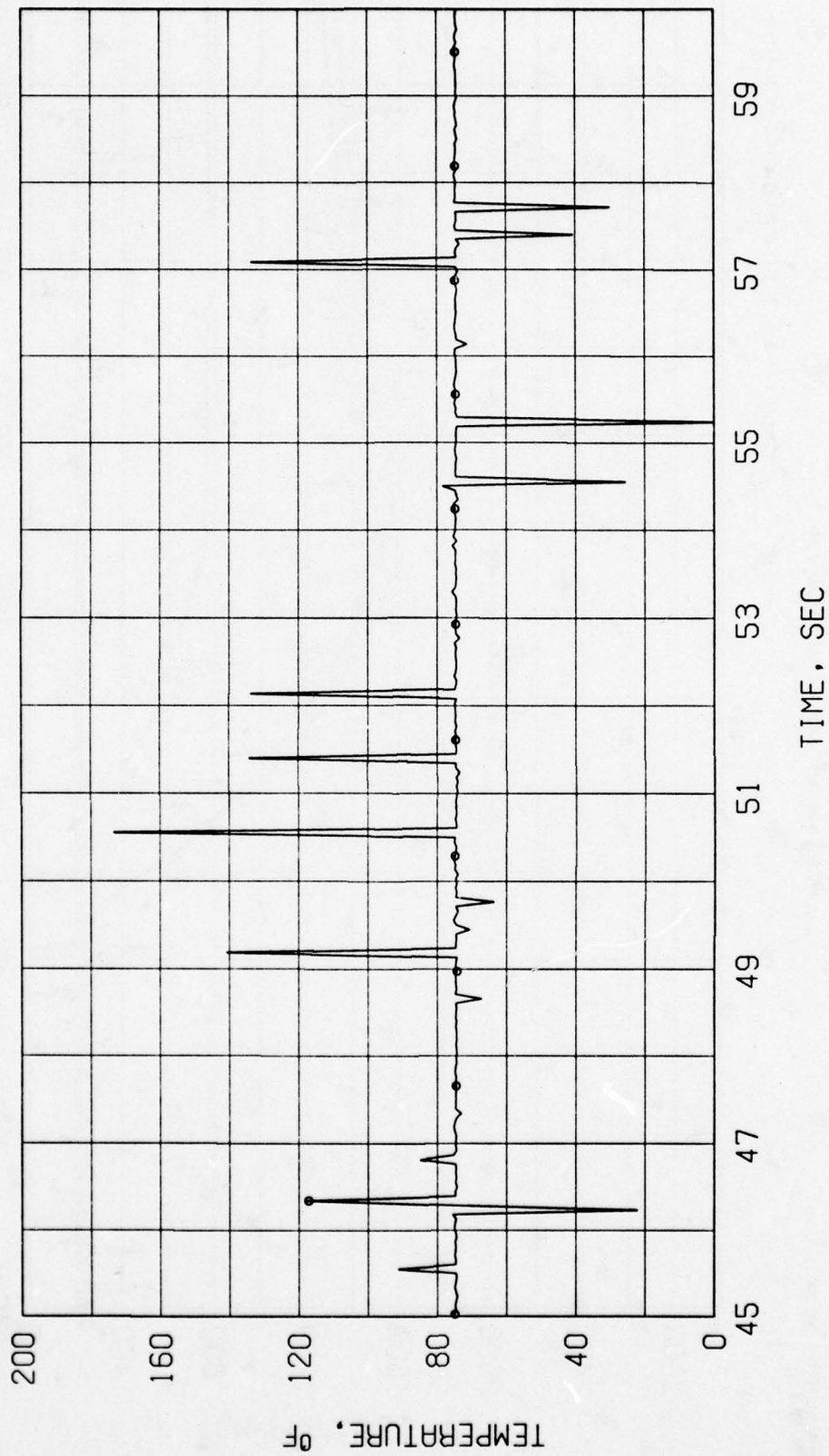
X TC-8-TI-2 + TC-7-TI-2 ▲ TC-6-TI-2 ○ TC-5-TI-2



DATE 01-14-77 RRO INC
PROJ-P41E

PROJECT P41E TEST R0021 DATE 01-12-77 SEL 2106

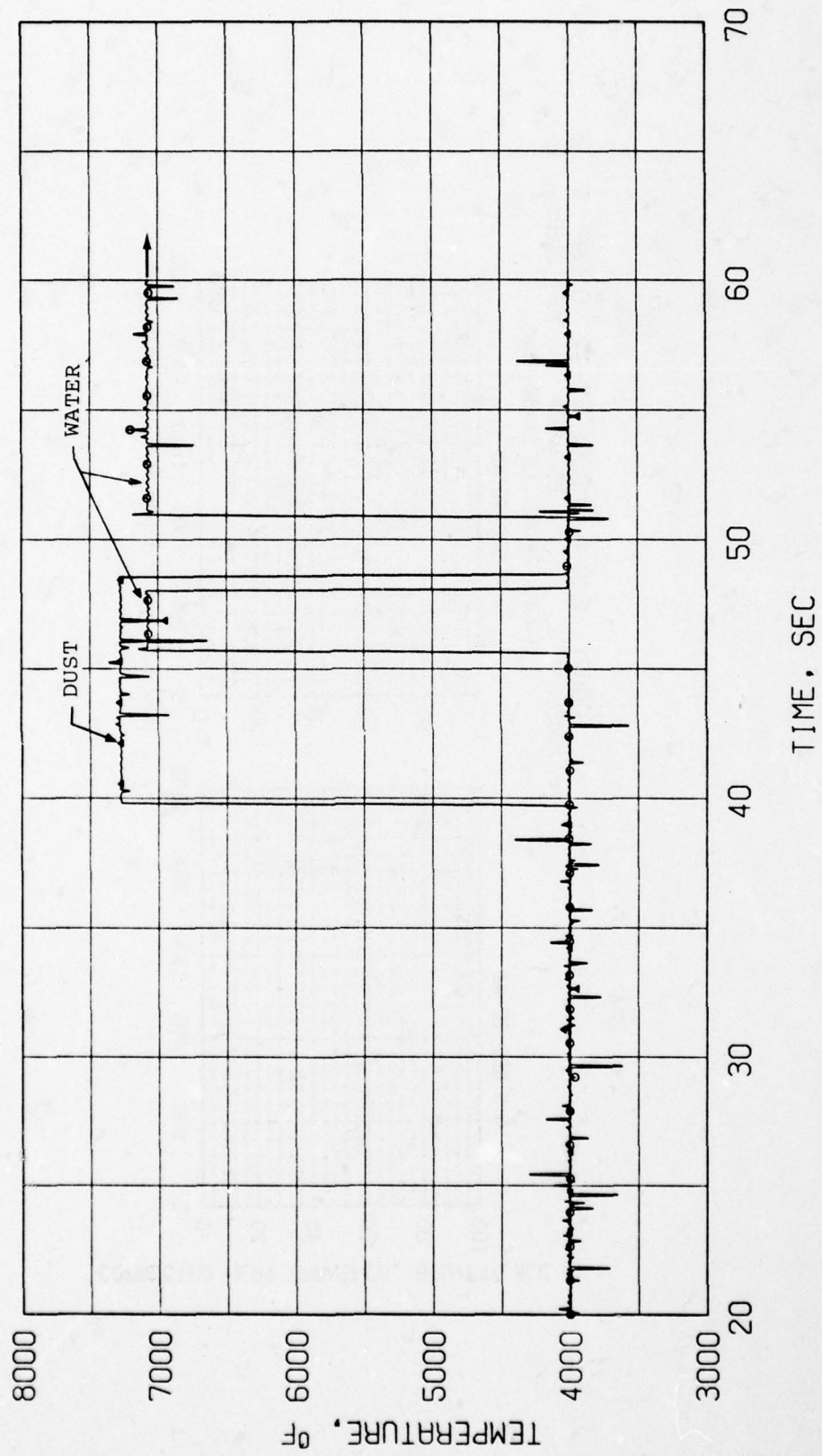
TC-9-T1-2



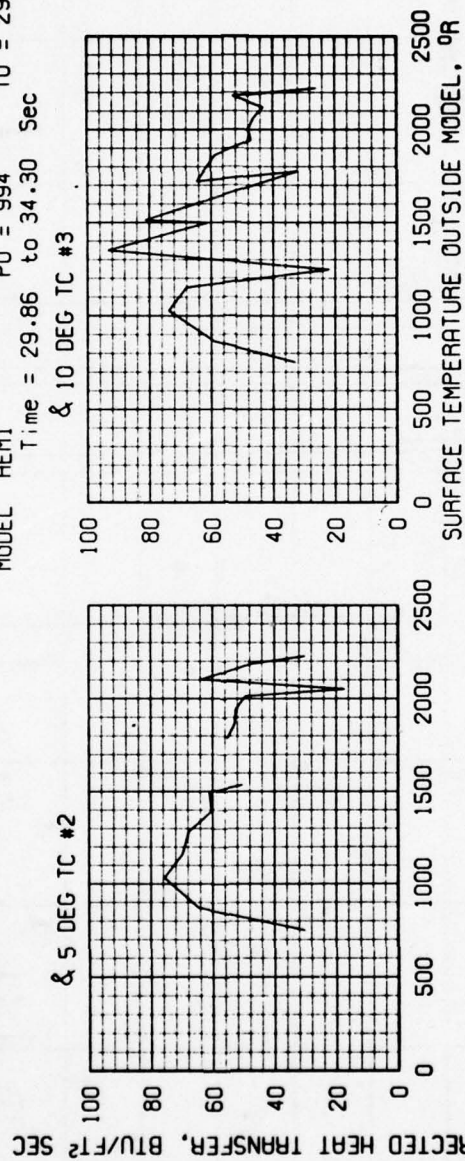
DATE 01-14-77 PRO INC
PROJ-P41E

PROJECT P41E TEST HQ021 DATE 01-12-77 SEL 2106

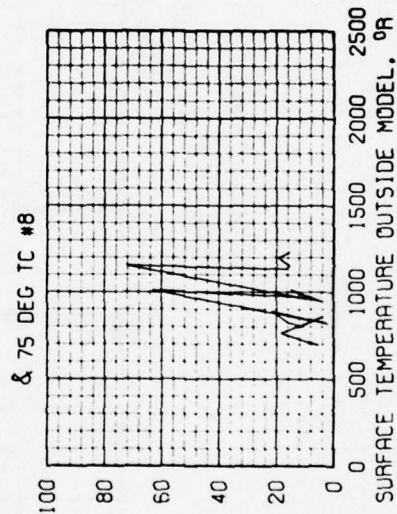
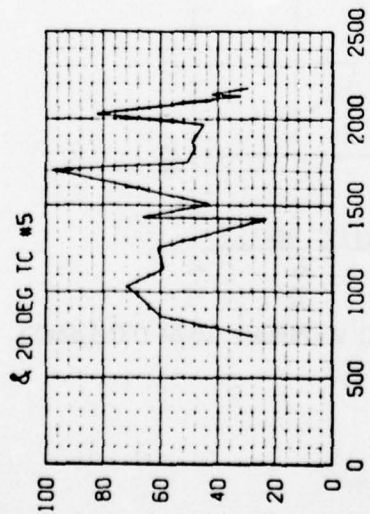
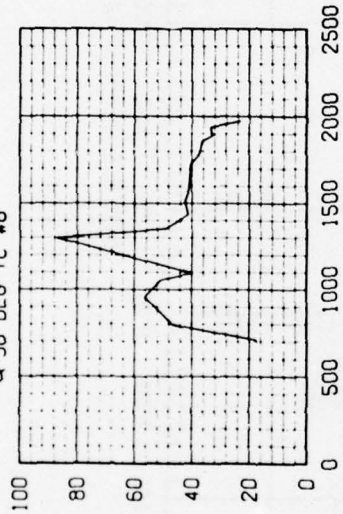
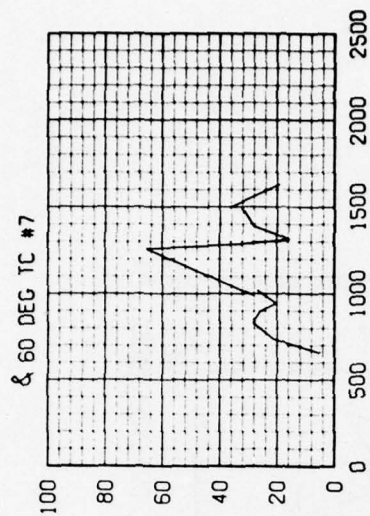
▲ DUST-EVENT ○ H2O-EVENT



AD021 RUN 6 MODEL TI-12 CLEAR
 MODEL HEMI P0 = 994 T0 = 2920
 Time = 29.86 to 34.30 Sec

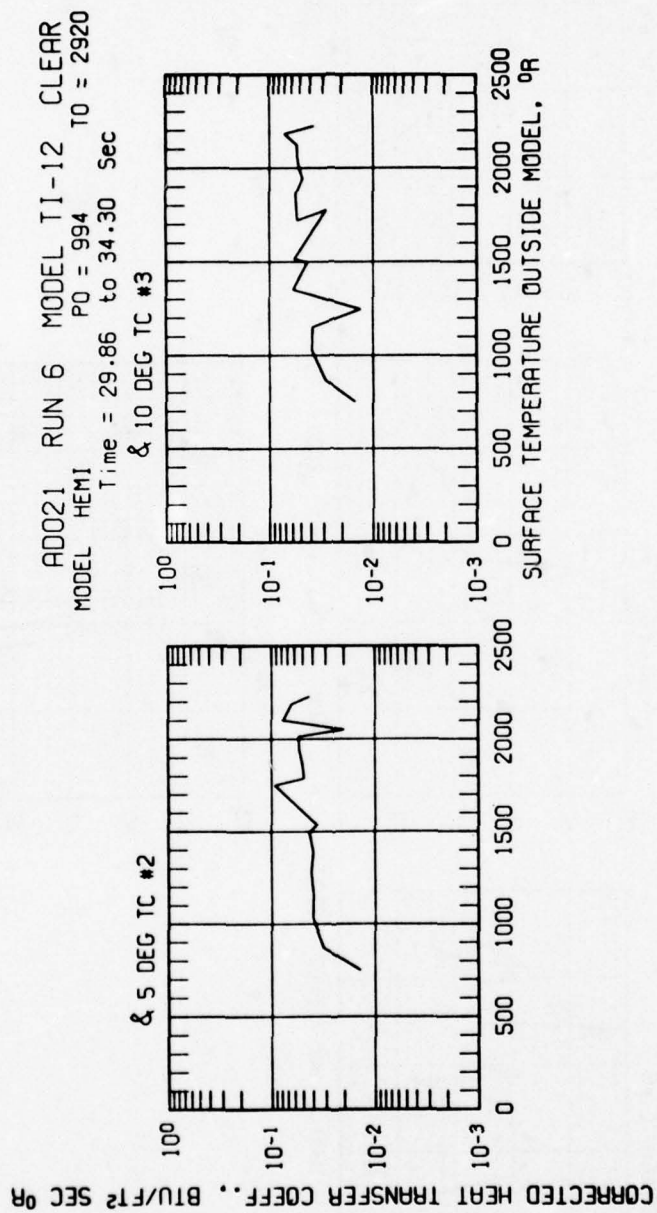


AD021 RUN 6 MODEL TI-12 CLEAR
 MODEL HEMI PO = 994 TO = 2920
 Time = 29.86 to 34.30 Sec

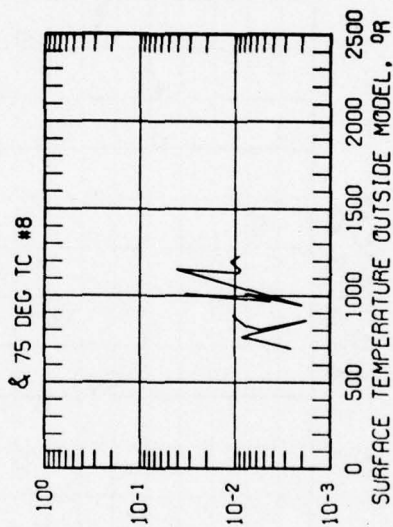
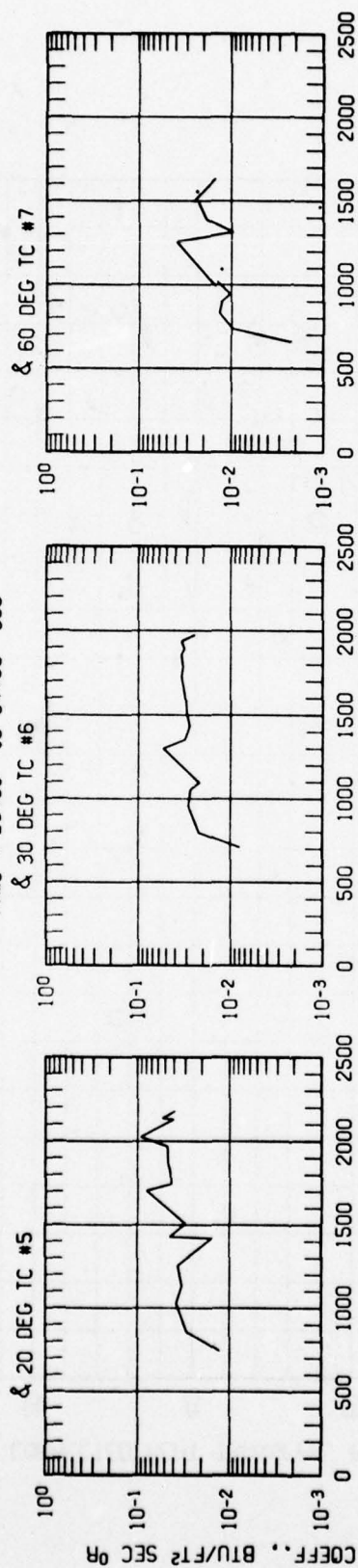


CORRECTED HEAT TRANSFER, BTU/FT² SEC

SURFACE TEMPERATURE OUTSIDE MODEL, °R



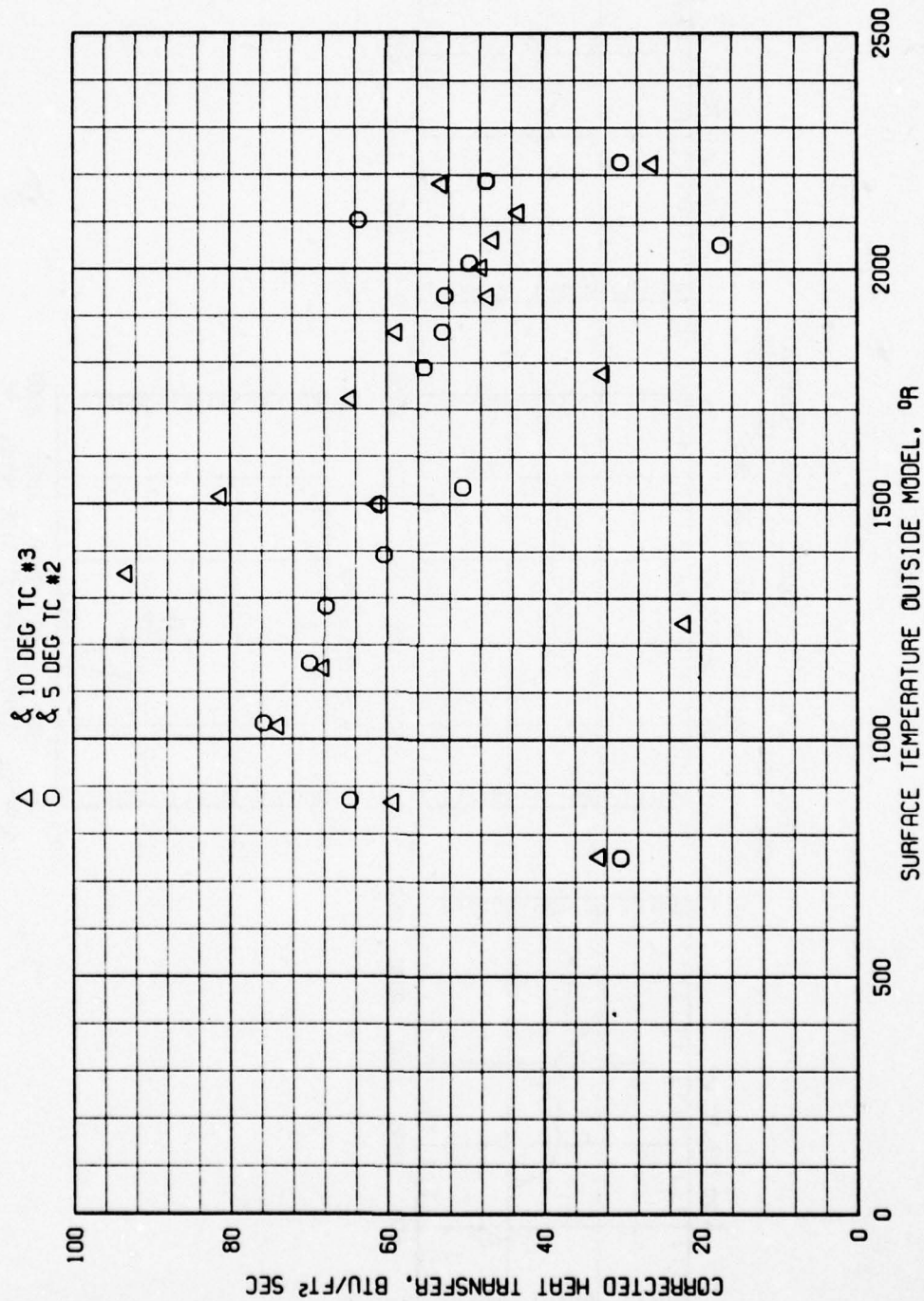
AD021 RUN 6 MODEL TI-12 CLEAR
 MODEL HEMI PO = 994 TO = 2920
 Time = 29.86 to 34.30 Sec



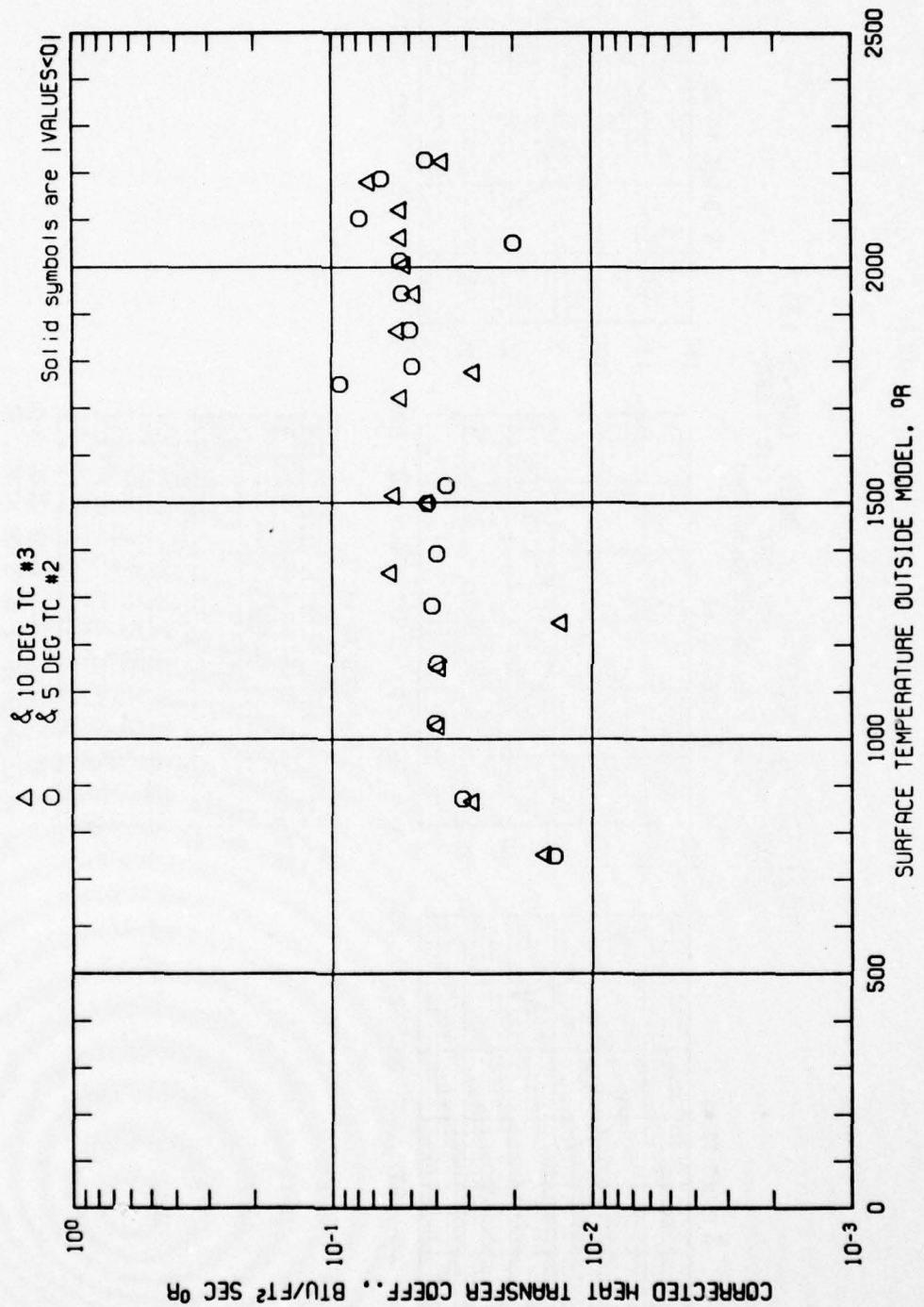
CORRECTED HEAT TRANSFER COEFF., BTU/FT² SEC

SURFACE TEMPERATURE OUTSIDE MODEL, °R

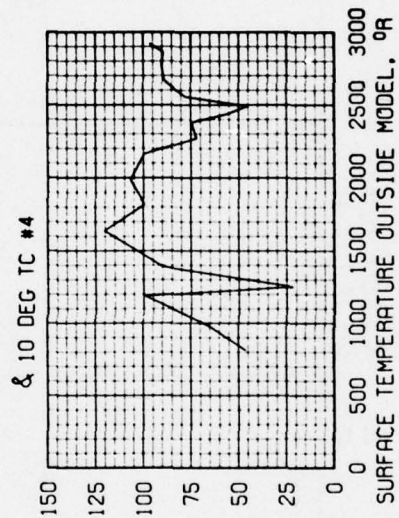
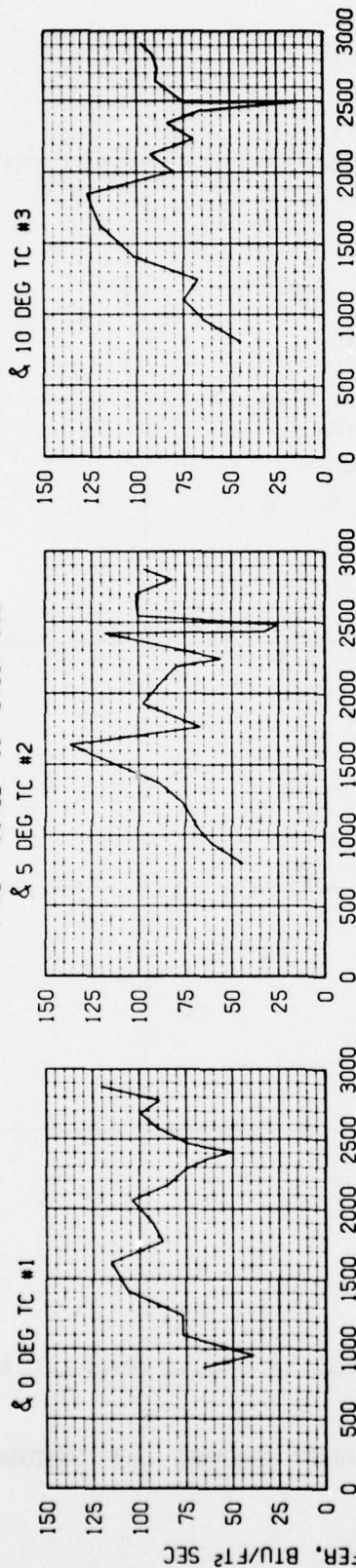
AD021 RUN 6 MODEL TI-12 CLEAR
 MODEL HEMI P0 = 994 T0 = 2920
 Time = 29.86 to 34.30 Sec



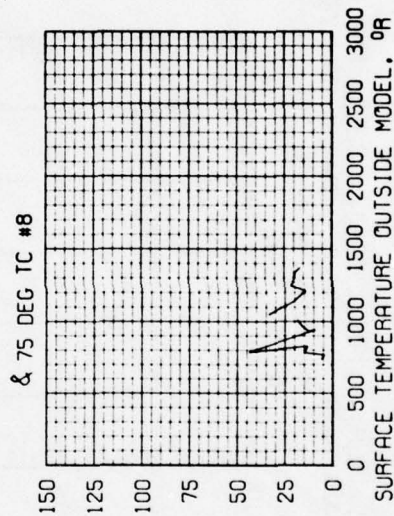
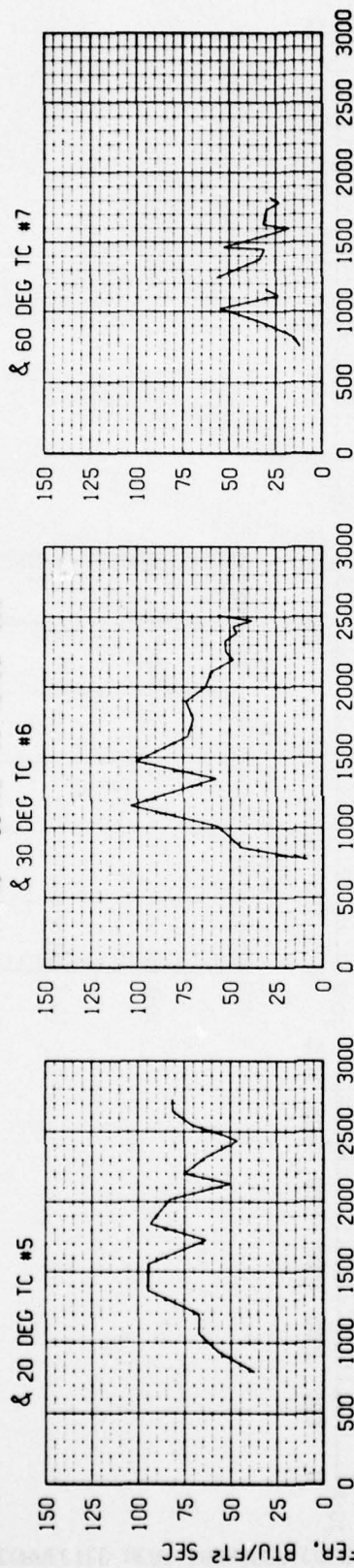
AD021 RUN 6 MODEL TI-12 CLEAR
 MODEL HEMI P0 = 994 T0 = 2920
 Time = 29.86 to 34.30 Sec



AD021 RUN 6 MODEL TI-13 DUST (NO CH 13)
 MODEL HEMI P0 = 994 T0 = 2920
 Time = 39.02 to 43.80 Sec



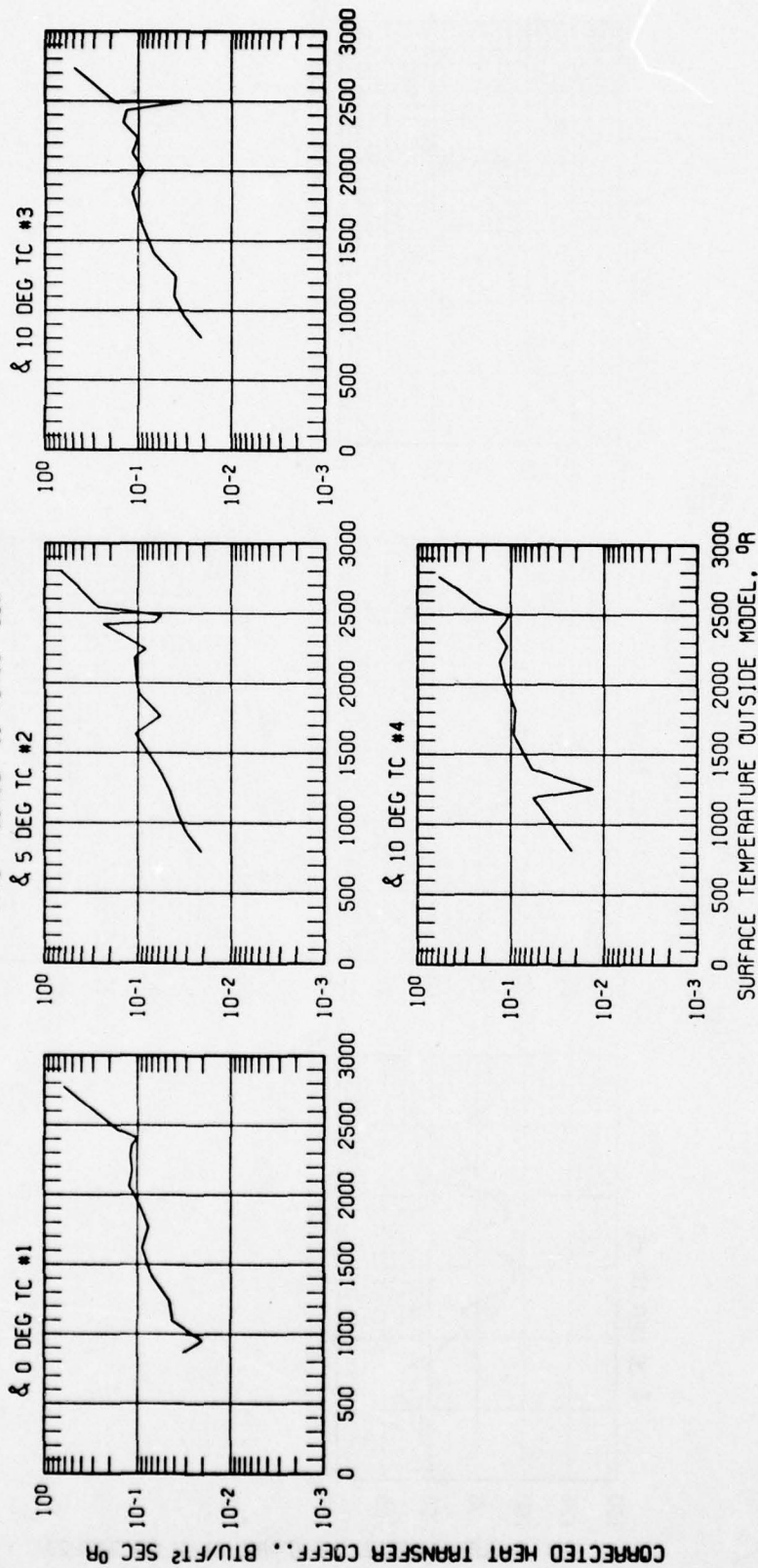
AD021 RUN 6 MODEL TI-13 DUST (NO CH 13)
 MODEL HEMI P0 = 994 T0 = 2920
 Time = 39.02 to 43.80 Sec



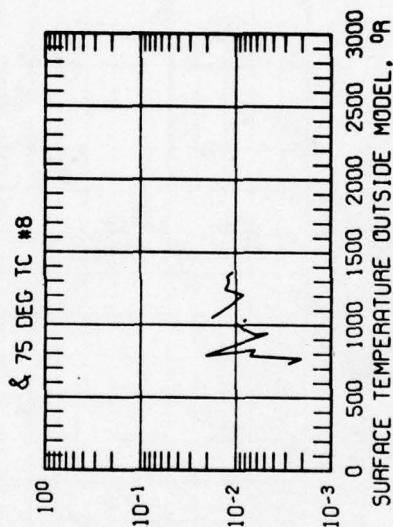
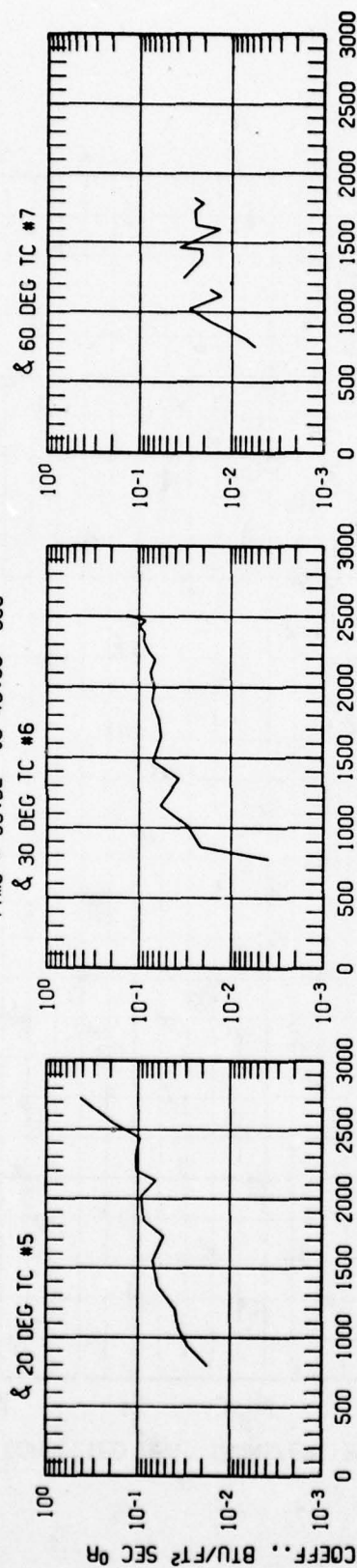
CORRECTED HEAT TRANSFER, BTU/FT² SEC

SURFACE TEMPERATURE OUTSIDE MODEL, °R

AD021 RUN 6 MODEL TI-13 DUST (NO CH 13)
 MODEL HEMI P0 = 994 T0 = 2920
 Time = 39.02 to 43.80 Sec



AD021 RUN 6 MODEL TI-13 DUST (NO CH 13)
 MODEL HEM1 P0 = 994 T0 = 2920
 Time = 39.02 to 43.80 Sec



CORRECTED HEAT TRANSFER COEFF., BTU/FT² SEC °R

0 500 1000 1500 2000 2500 3000
 SURFACE TEMPERATURE OUTSIDE MODEL, °R

AD0021 RUN 6 MODEL TI-13 DUST (NO CH 13)

MODEL HEMI

PO = 994

T0 = 2920

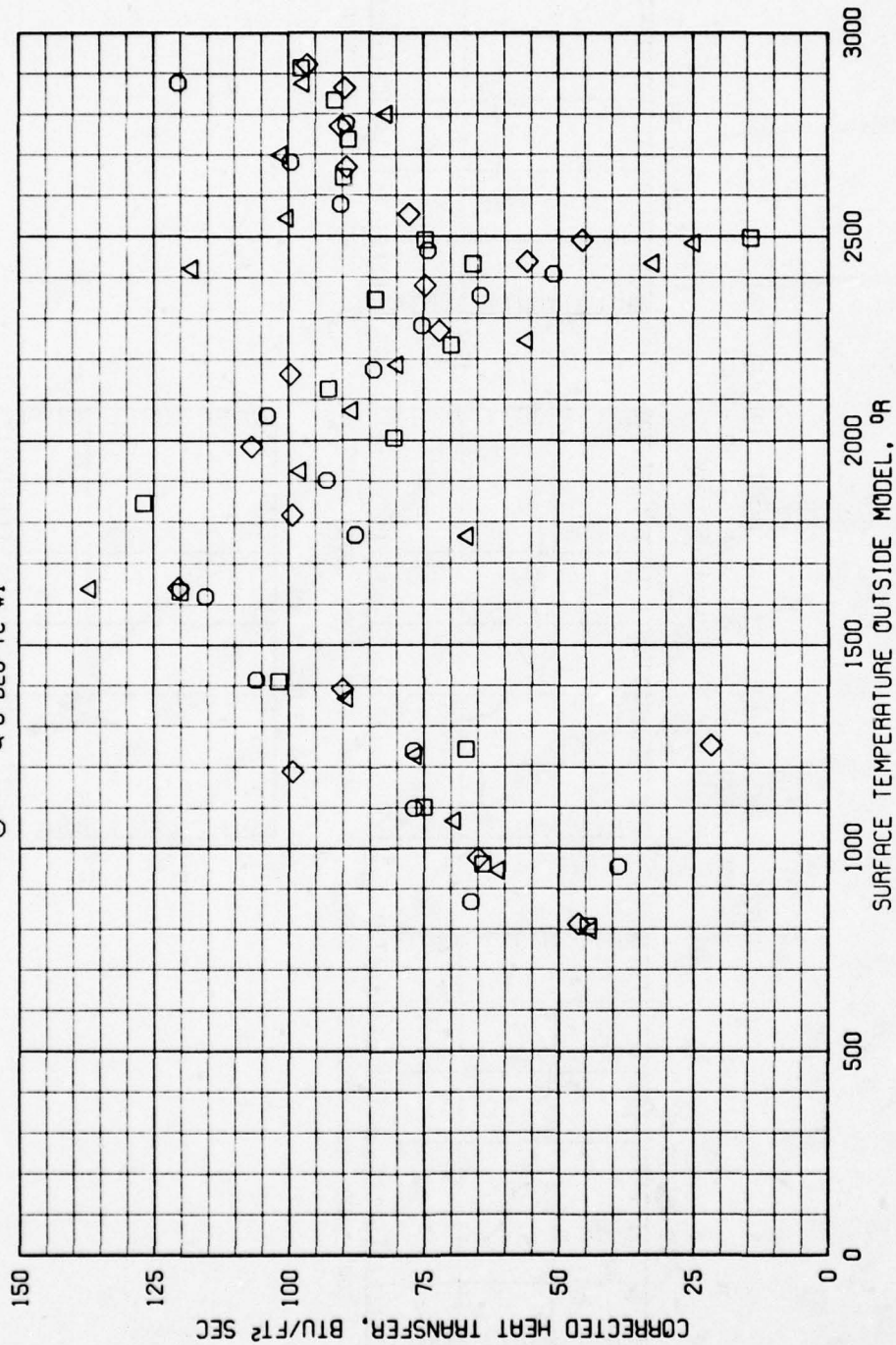
Time = 39.02 to 43.80 Sec

◇ 10 DEG TC #4

□ 10 DEG TC #3

△ 5 DEG TC #2

○ 0 DEG TC #1



AD021 RUN 6 MODEL TI-13 DUST (NO CH 13)

MODEL HEMI

PO = 994

TO = 2920

Time = 39.02 to 43.80 Sec

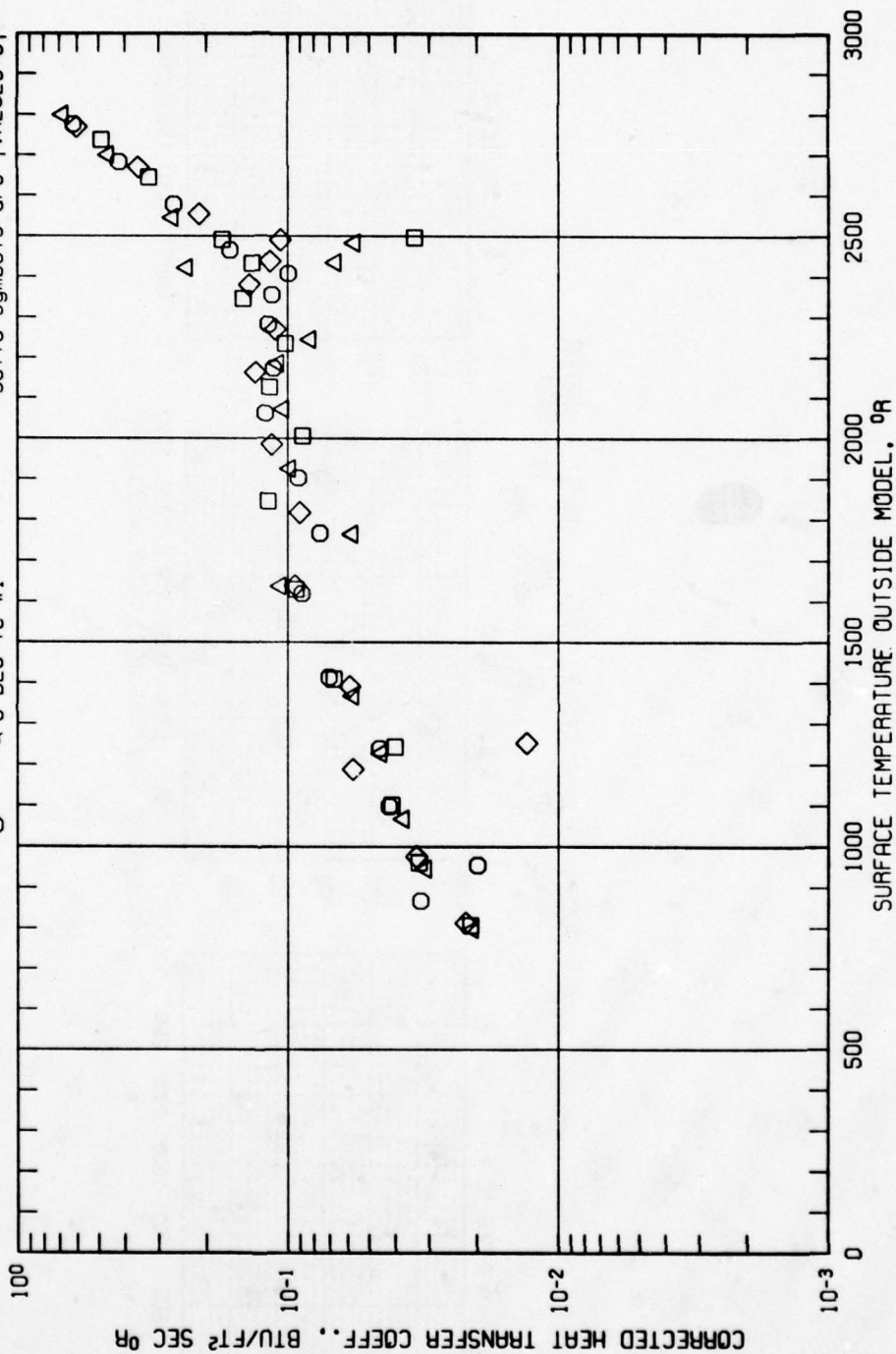
◇ & 10 DEG TC #4

□ & 10 DEG TC #3

△ & 5 DEG TC #2

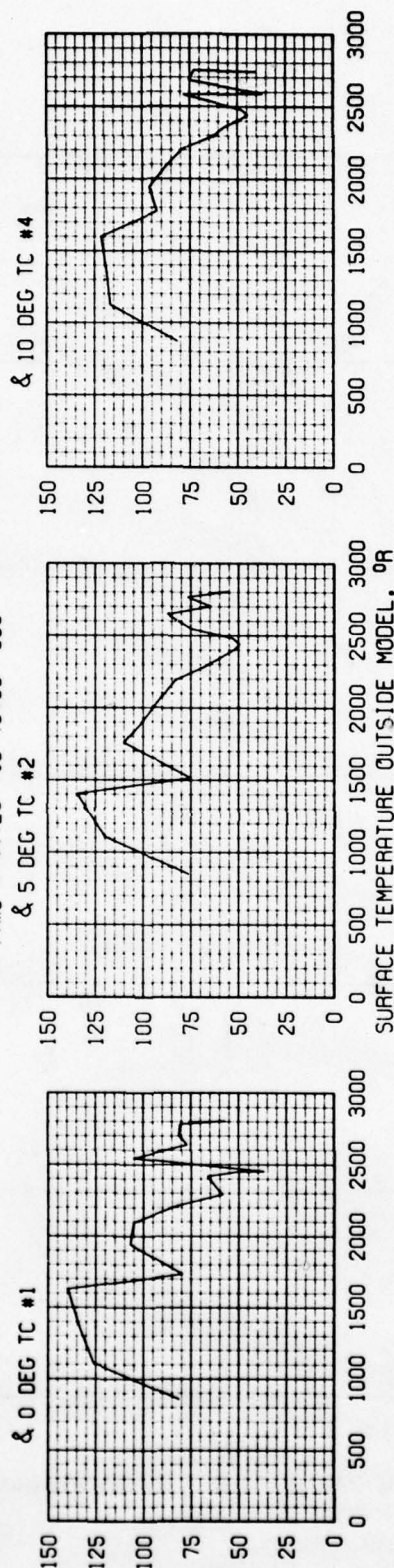
○ & 0 DEG TC #1

Solid symbols are |VALUES<0|

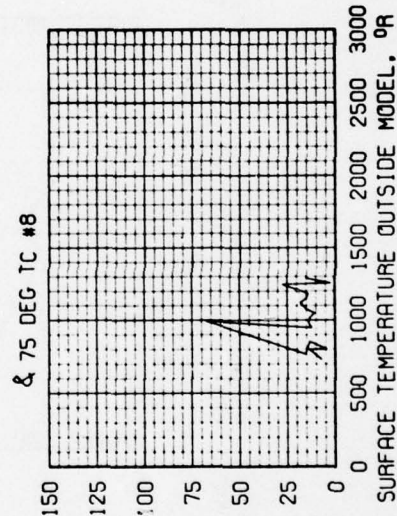
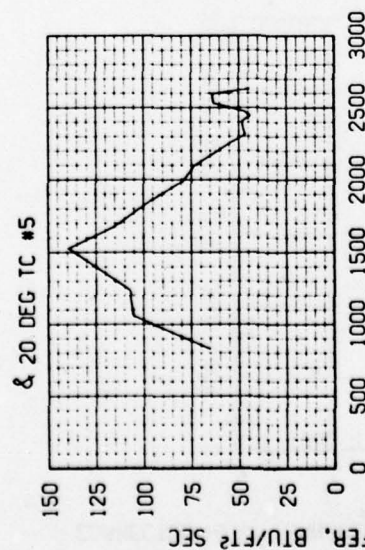
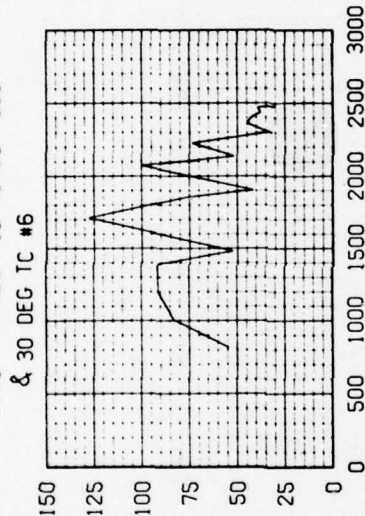
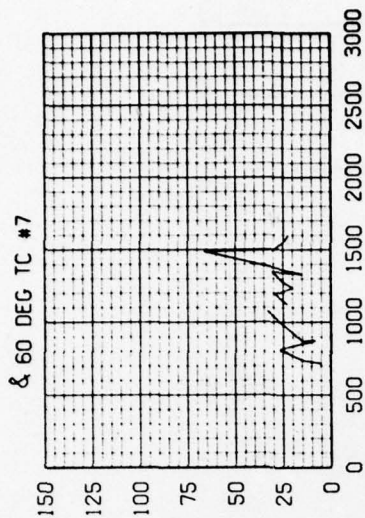


CORRECTED HEAT TRANSFER, BTU/FT² SEC

AD0021 RUN 6 MODEL TI-11 DUST + WATER
 MODEL HEMI P0 = 994 T0 = 2920
 Time = 44.23 to 49.00 Sec

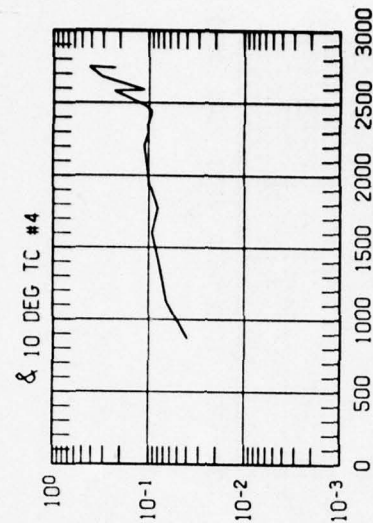
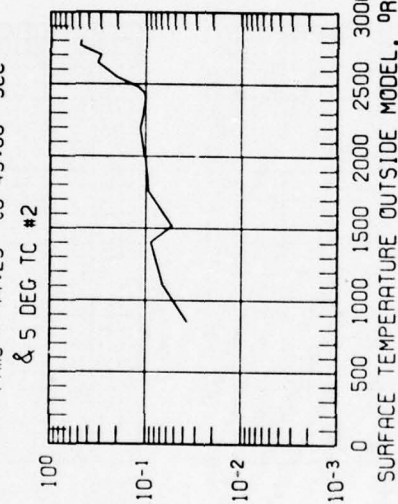
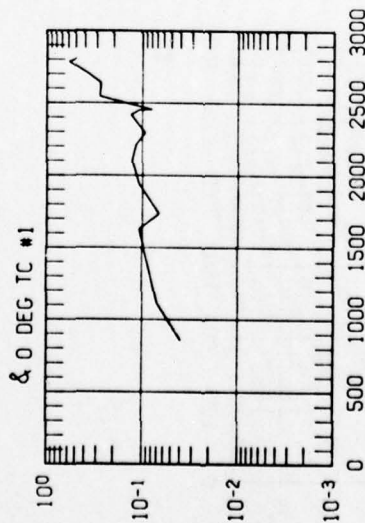


AD021 RUN 6 MODEL TI-11 DUST + WATER
 HEMI P0 = 994 T0 = 2920
 Time = 44.23 to 49.00 Sec



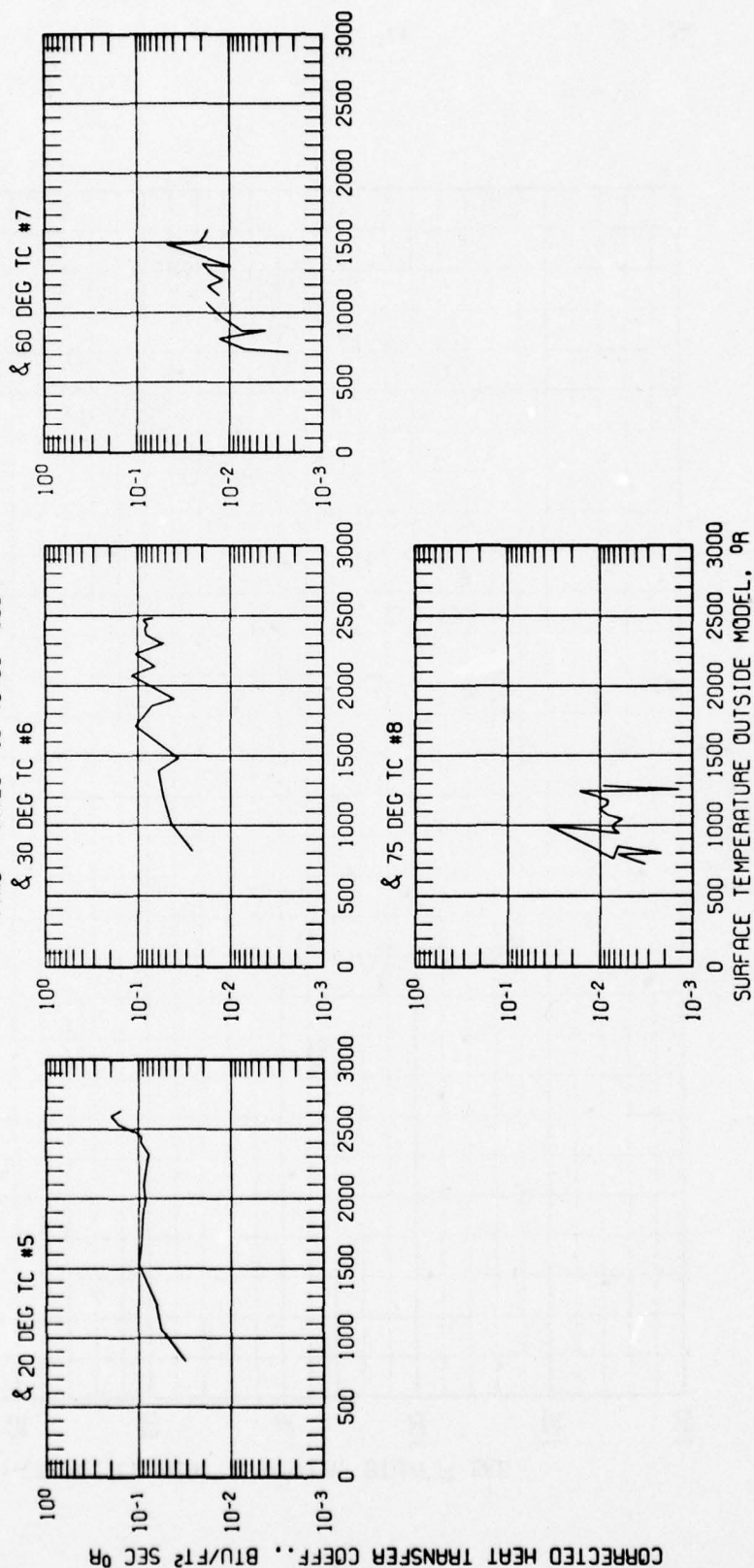
SURFACE TEMPERATURE OUTSIDE MODEL, °R

CORRECTED HEAT TRANSFER COEFF., BTU/FT² SEC °R



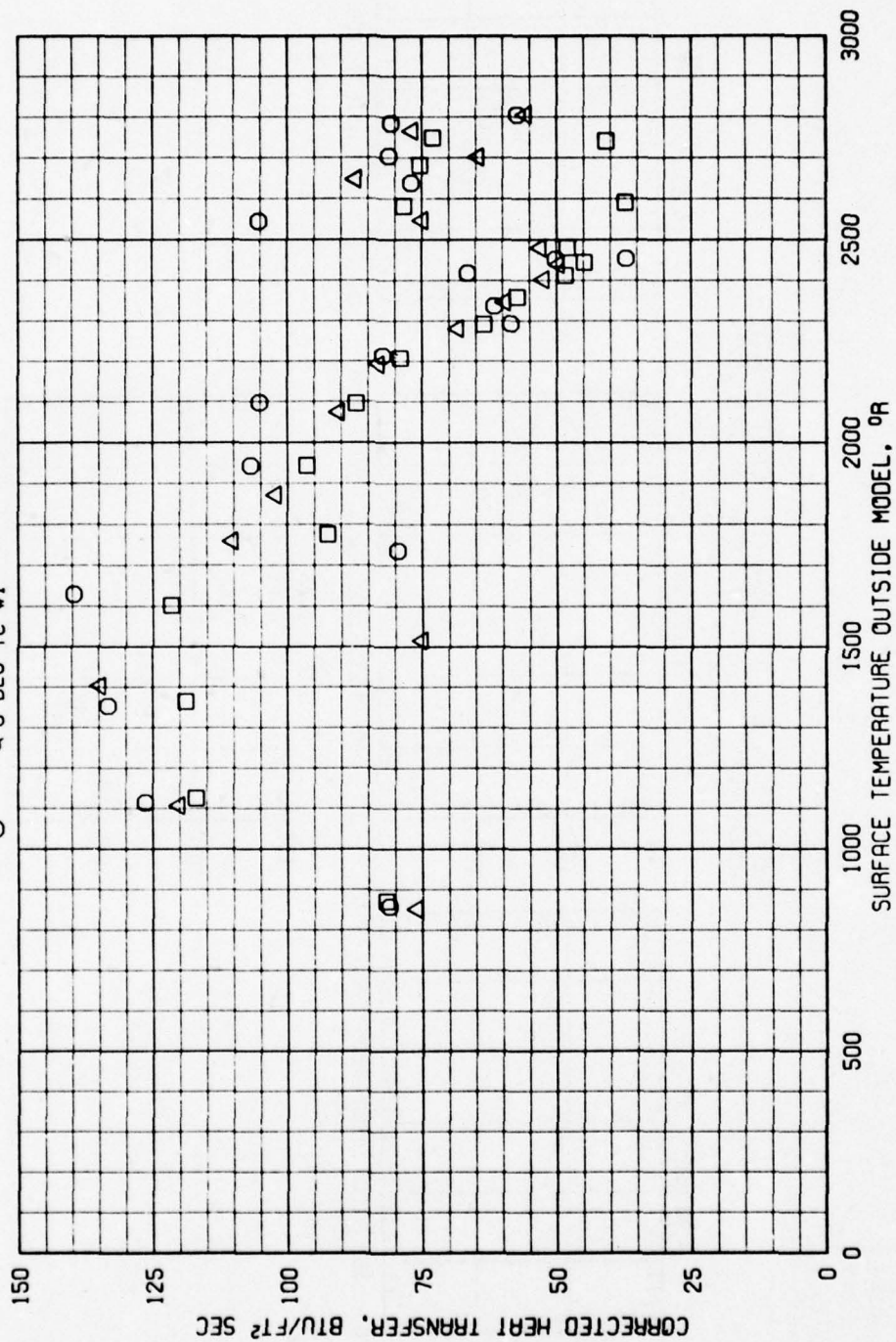
AD021 RUN 6 MODEL T1-11 DUST + WATER
 MODEL HEMI P0 = 994 T0 = 2920
 Time = 44.23 to 49.00 Sec

AD021 RUN 6 MODEL T1-11 DUST + WATER
 MODEL HEMI P0 = 994 T0 = 2920
 Time = 44.23 to 49.00 Sec



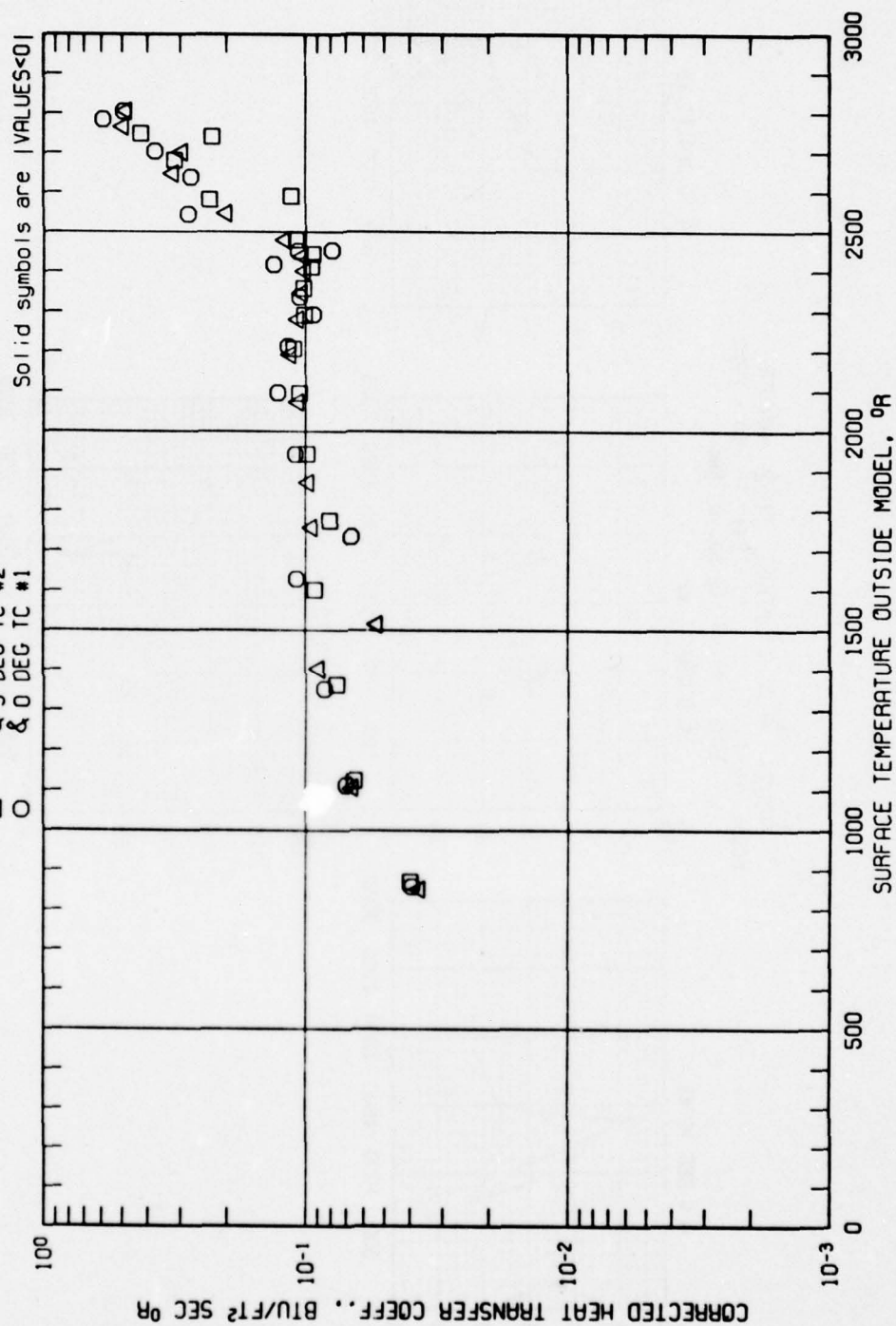
AD021 RUN 6 MODEL TI-11 DUST + WATER
 MODEL HEMI P0 = 994 T0 = 2920
 Time = 44.23 to 49.00 Sec

□ & 10 DEG TC #4
 △ & 5 DEG TC #2
 ○ & 0 DEG TC #1

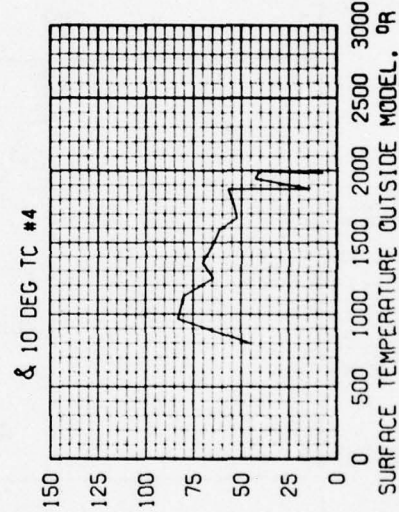
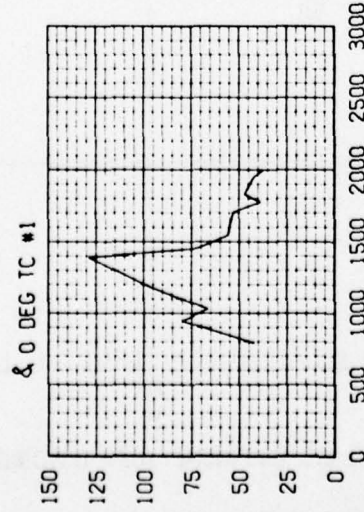
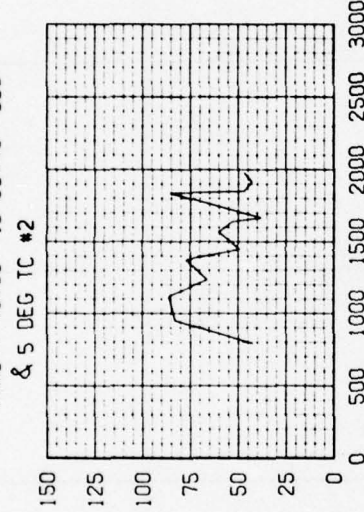
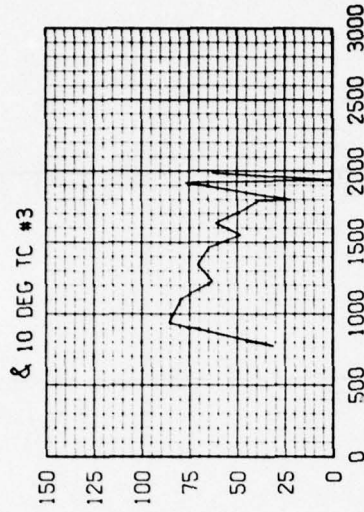


AD0021 RUN 6 MODEL TI-11 DUST + WATER
 MODEL HEMI P0 = 994 T0 = 2920
 Time = 44.23 to 49.00 Sec

□ 10 DEG TC #4
 △ 5 DEG TC #2
 ○ 0 DEG TC #1

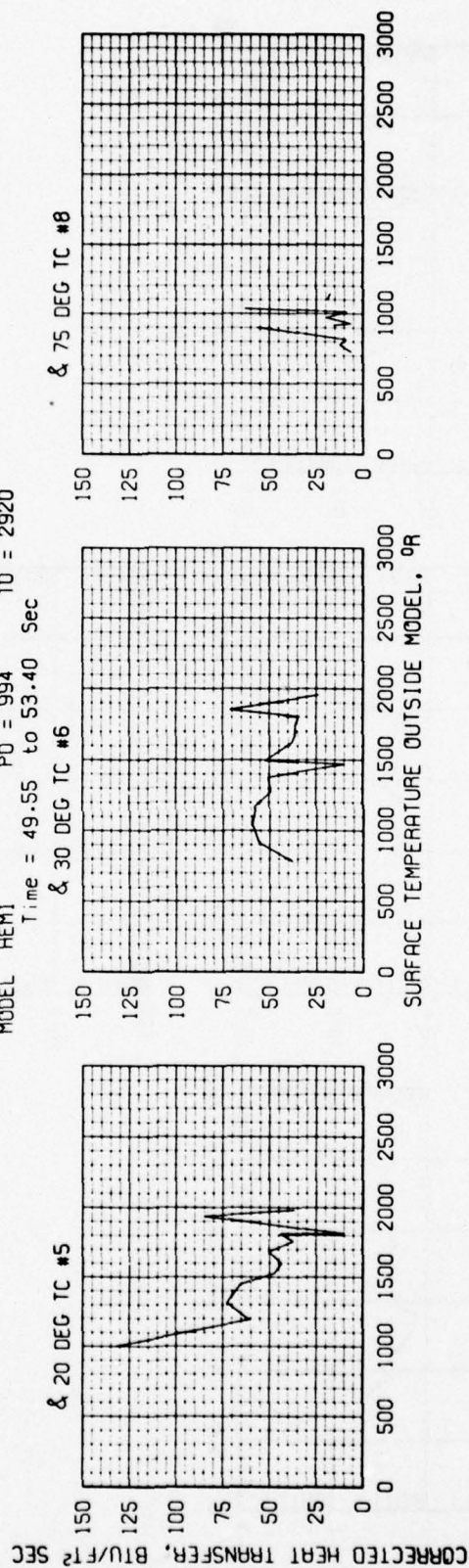


ADO21 RUN 6 MODEL TI-2 WATER
 MODEL HEMI P0 = 994 T0 = 2920
 Time = 49.55 to 53.40 Sec

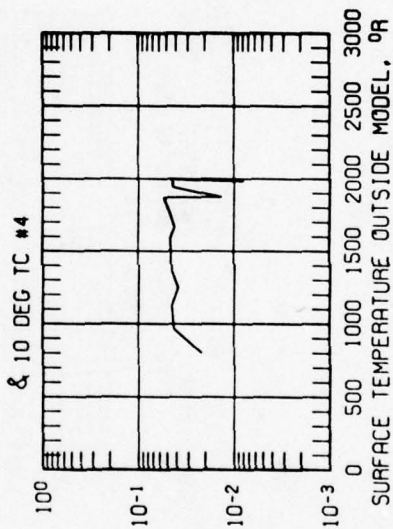
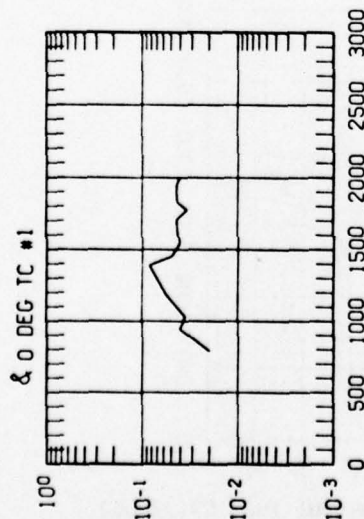
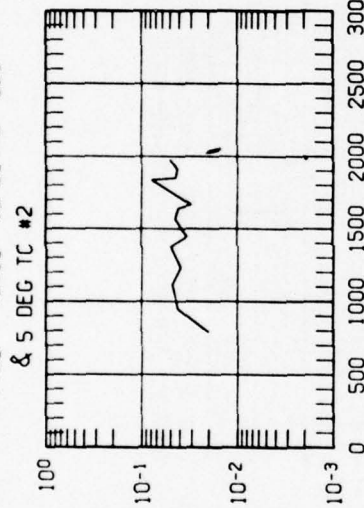
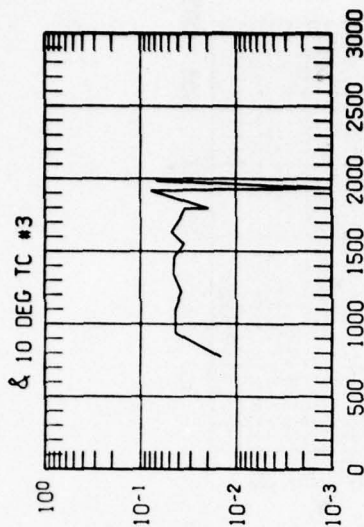


CORRECTED HEAT TRANSFER, BTU/FT² SEC

AD0021 RUN 6 MODEL TI-2 WATER
 MODEL HEMI PO = 994 TO = 2920
 Time = 49.55 to 53.40 Sec



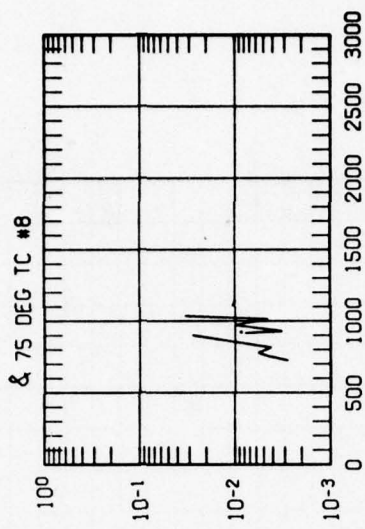
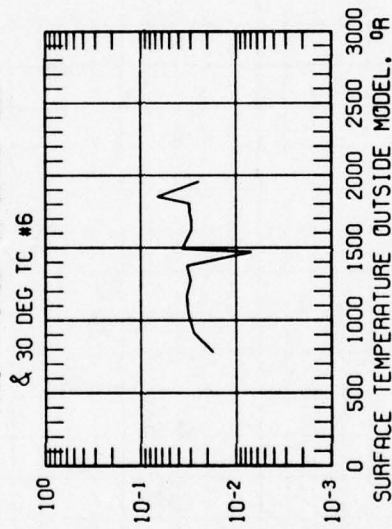
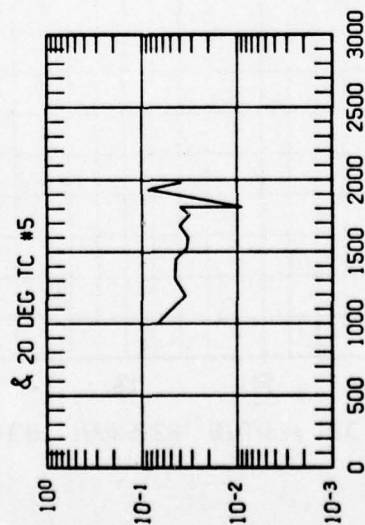
AD021 RUN 6 MODEL T1-2 WATER
 MODEL HEMI P0 = 994 T0 = 2920
 Time = 49.55 to 53.40 Sec



CORRECTED HEAT TRANSFER COEFF., BTU/FT² SEC OR

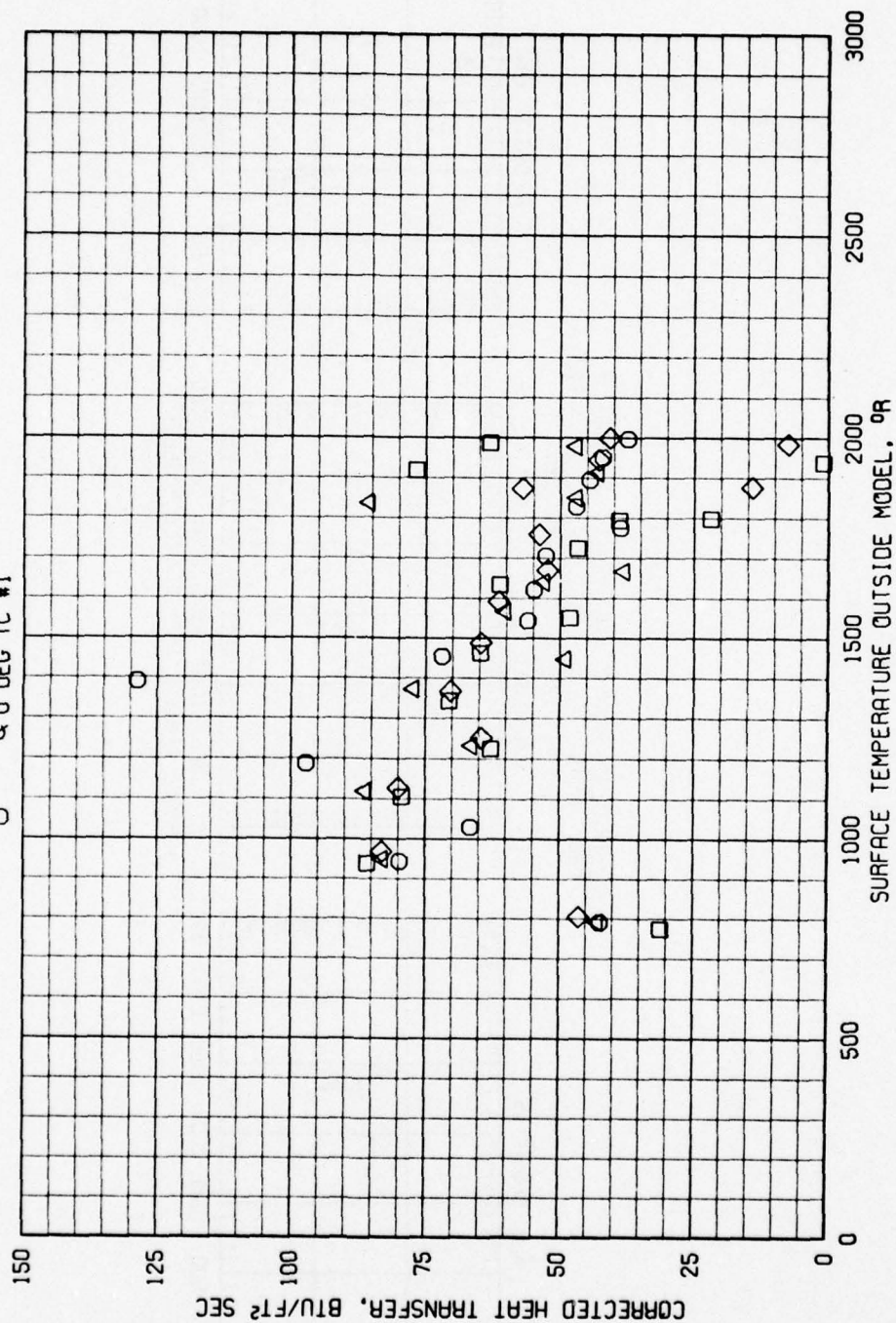
SURFACE TEMPERATURE OUTSIDE MODEL, OR

CORRECTED HEAT TRANSFER COEFF., BTU/FT² SEC °R



AD021 RUN 6 MODEL T1-2 WATER
 MODEL HEMI P0 = 994 T0 = 2920
 Time = 49.55 to 53.40 Sec

AD021 RUN 6 MODEL TI-2 WATER
 MODEL HEMI P0 = 994 T0 = 2920
 Time = 49.55 to 53.40 Sec
 & 10 DEG TC #4
 & 10 DEG TC #3
 & 5 DEG TC #2
 & 0 DEG TC #1



AD021 RUN 6 MODEL TI-2 WATER
 MODEL HEMI P0 = 994 T0 = 2920
 Time = 49.55 to 53.40 Sec

◇ 10 DEG TC #4
 □ 10 DEG TC #3
 △ 5 DEG TC #2
 ○ 0 DEG TC #1

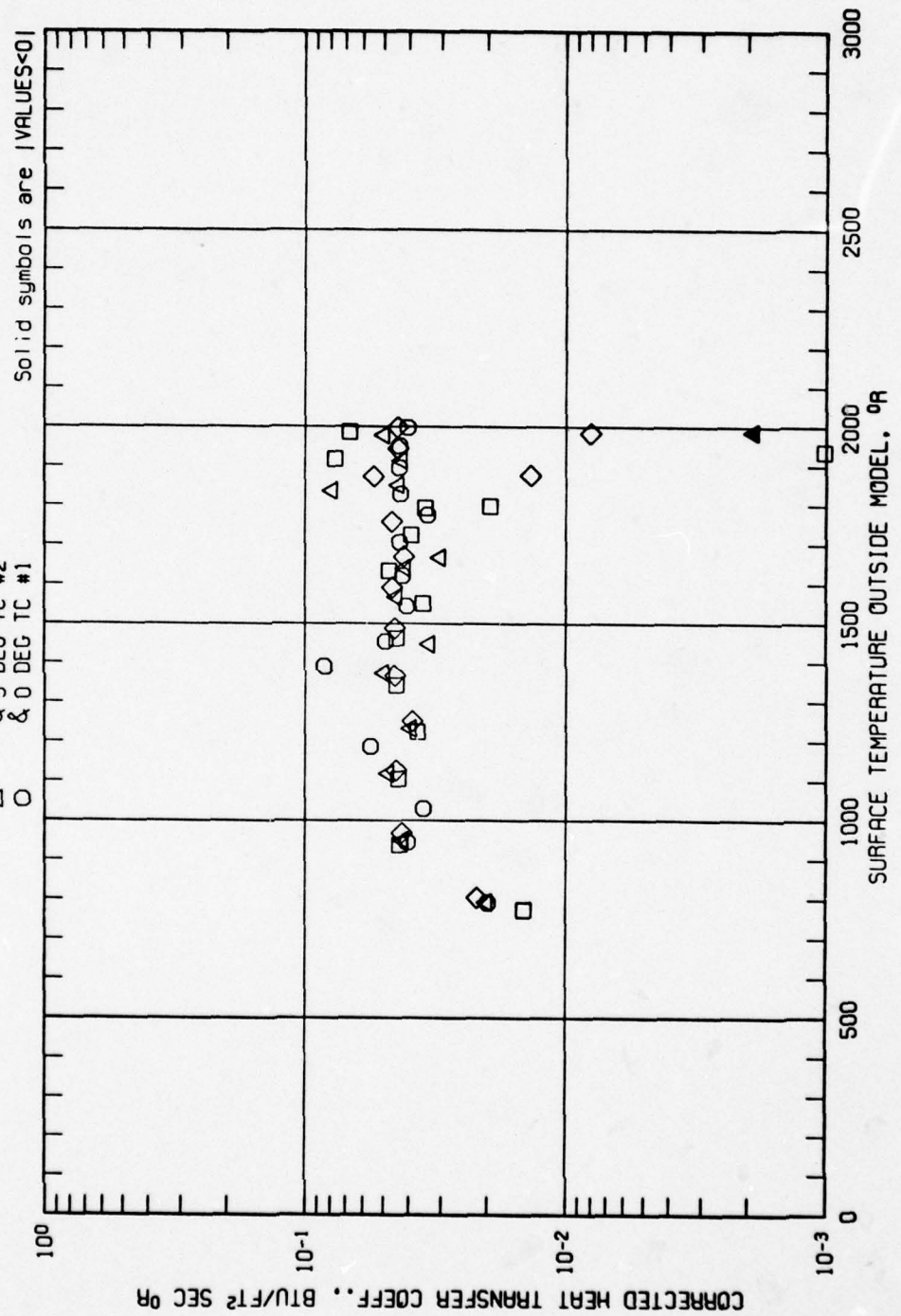


TABLE 1 RUN SUMMARY

TUNNEL CONDITIONS

$P_o = 1002$ psia, $P_{om} = 1018$
 $H_{og} = 1805$ Btu/lbm, $H_{om} = 1718$
 $P_o = 5900$ R, $T_o =$ °R
 $M = 6.65$ $P_o' = 9.83$ psia

RUN 7 DATE 1-14-77
 NOZZLE STATION 127.5

DUST
 TYPE MgO
 SIZE 100 μ m
 VEL 5530 ft/sec Orifice
 Flow 10.89 gm/sec ΔP
 C.F. 26.6

WATER
 Flow 0.42 gpm
 C.F. 29.0
 Orifice 0.02 in.
 972 psi

S E R I E S N O	MODEL NUMBER	EXPOSURE TIME				MODEL DESCRIPTION			MODEL INSTRUMENTATION					PHOTOGRAPHS		
		PH	DUST	H ₂ O	DUST & H ₂ O	POH	GEOMETRY	DIAM, In.	MATERIAL	T/C TYPE	NO. OF T/C s	PR. TAP	NO. OF TAPS	TRANS- DUCER TYPE	PRERUN	POSTRUN
1	Po' probe	3.13					See Fig. 3	1.0	SS			x	1	Strain Gage		
2	T _i -22	6.22					Hemi	3.0	6A1-4V-T _i	S	8				94	276
3	WB-3S WB-3A	4.19					See Fig. 2		SS Al							281
4	T _i -54	0.88	3.82				Hemi	3.0	6A1-4V-T _i	S	8				96	279
5	T _i -53		3.18 2.71	-	x		Hemi	3.0	6A1-4V-T _i	S	8				97	278
6	T _i -23	2.95		2.81			Hemi	3.0	6A1-4V-T _i	S	8				93	277
7	WB-4S WB-4A			5.67			See Fig. 2		SS Al							280
8																
9																
10																

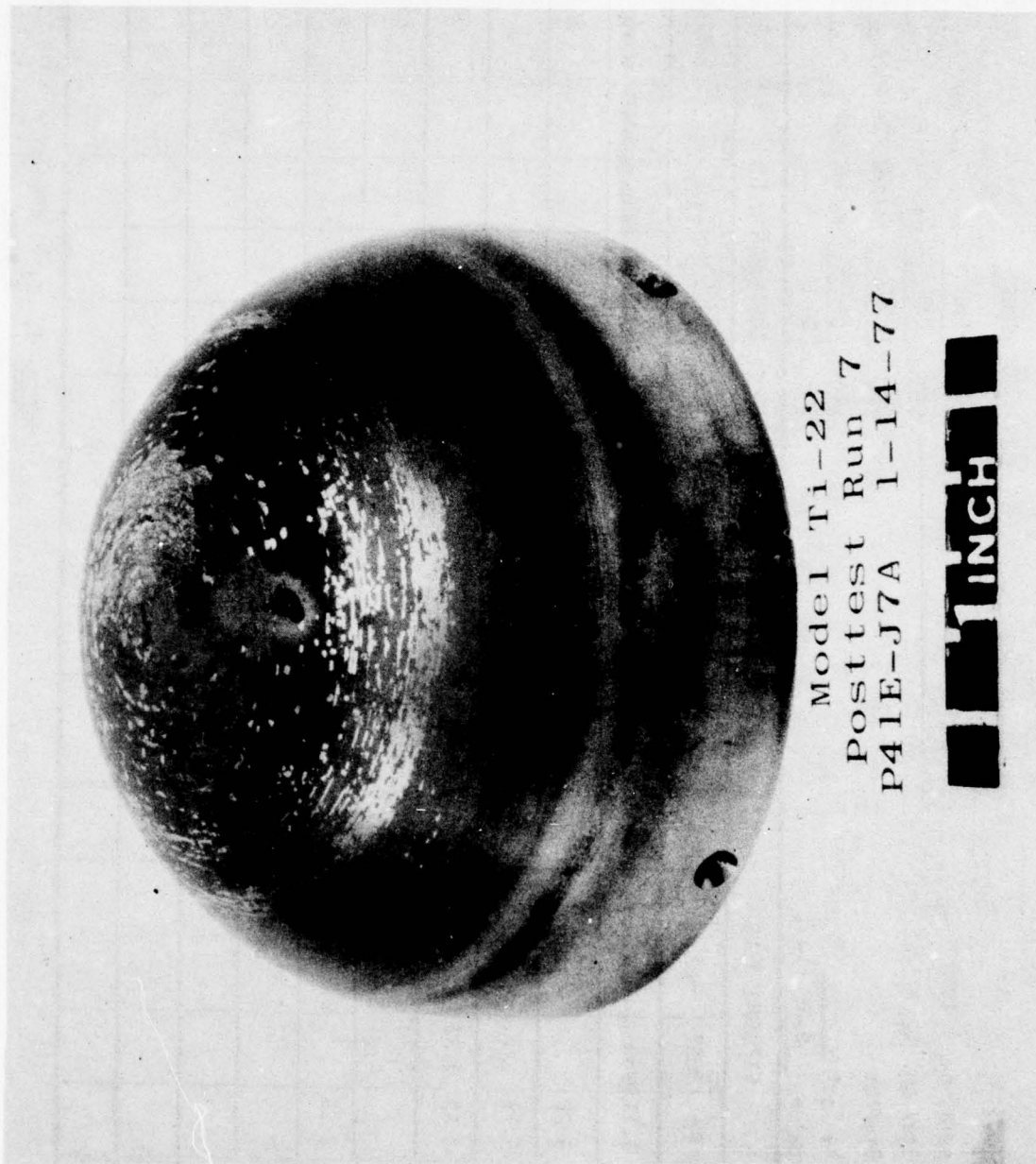
KEY -

PH - PREHEAT

POH - POSTHEAT

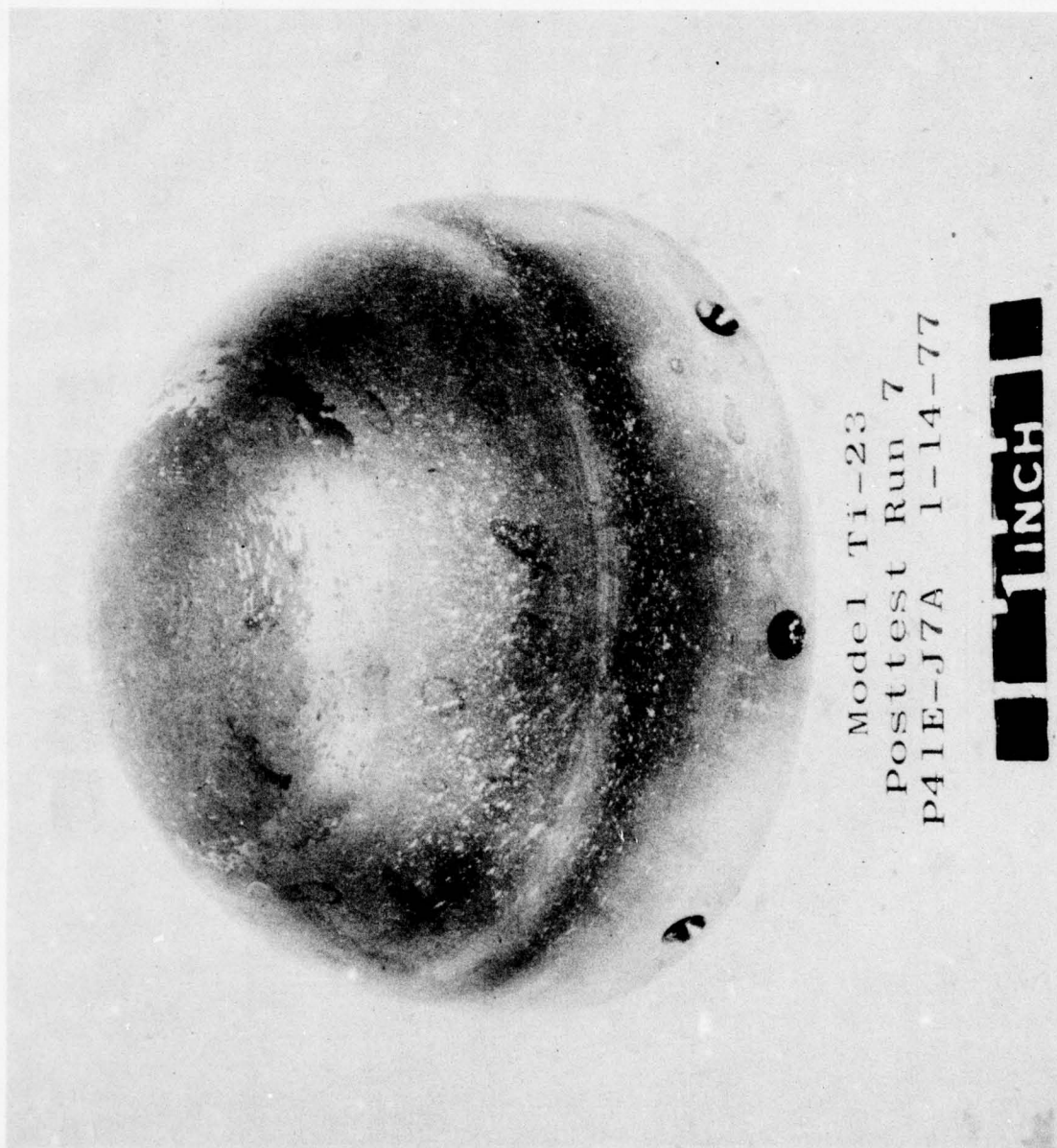
DUST AND H₂O - IF CHECKED, MEANS DUST AND WATER FLOWING AT SAME TIME

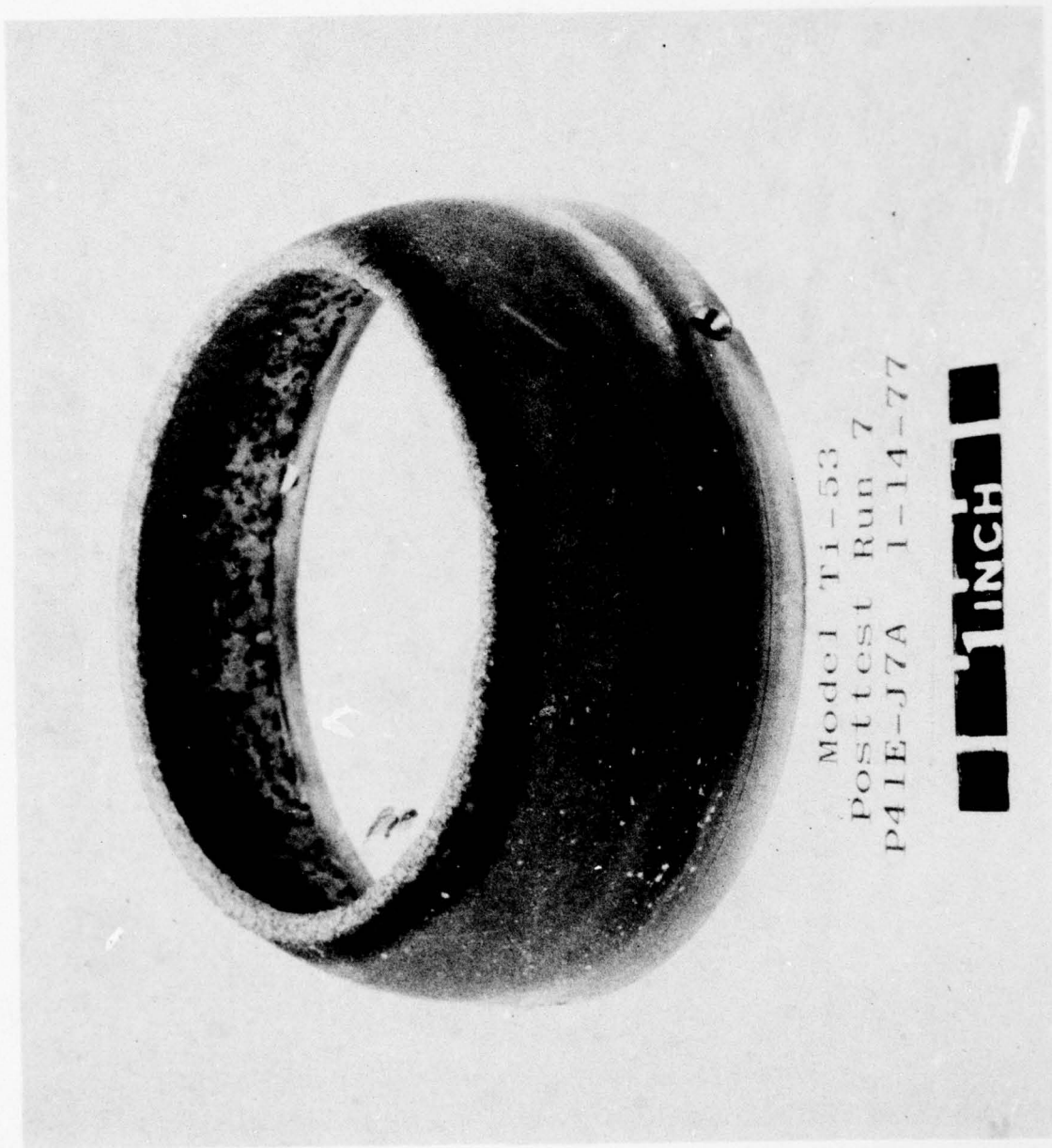
NOTES: 1. T_i-54 and T_i-53 burned through;
 2 pinholes burned in T_i-22.

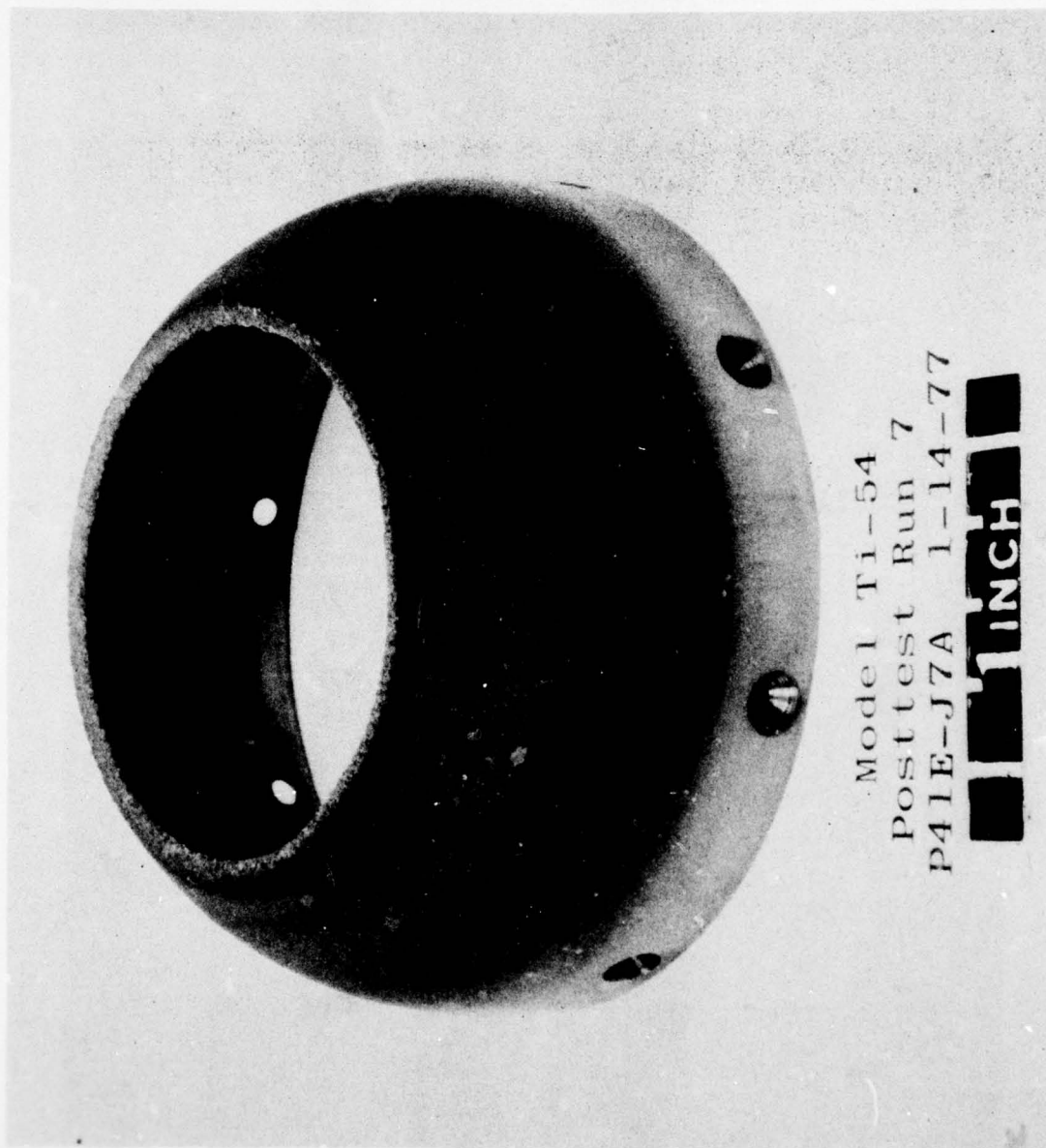


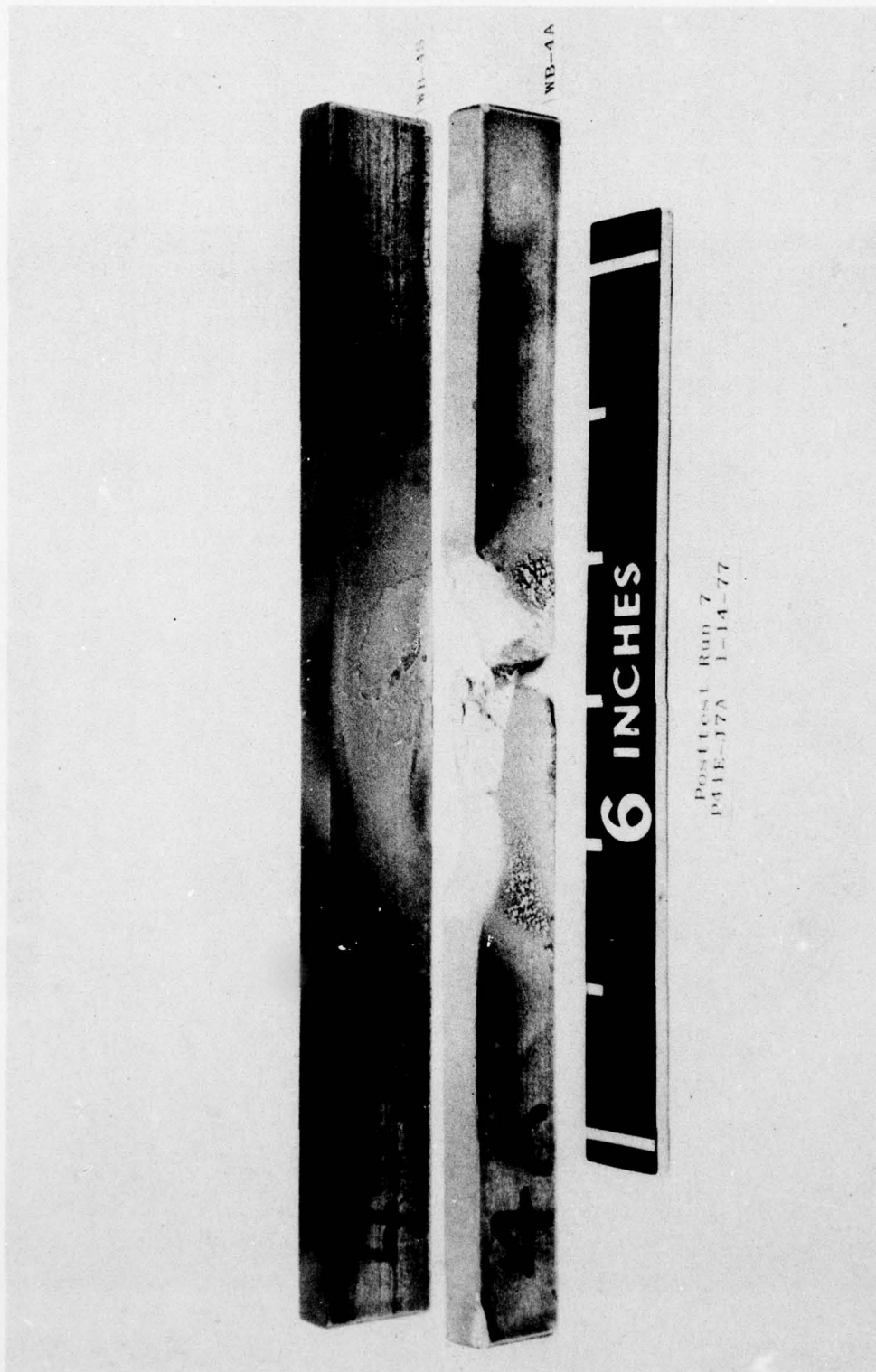
Model Ti-22
Post test Run 7
P41E-J7A 1-14-77

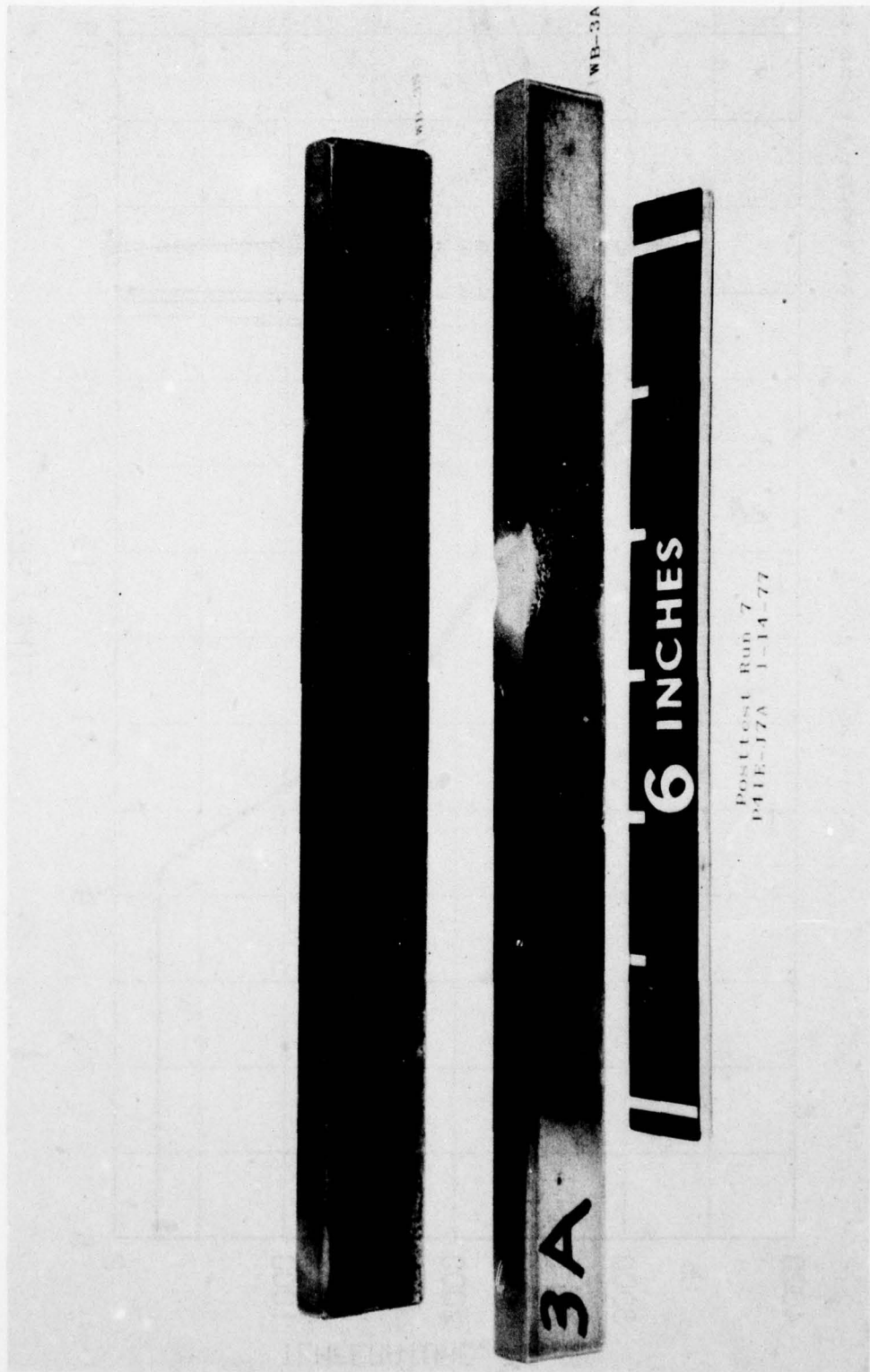








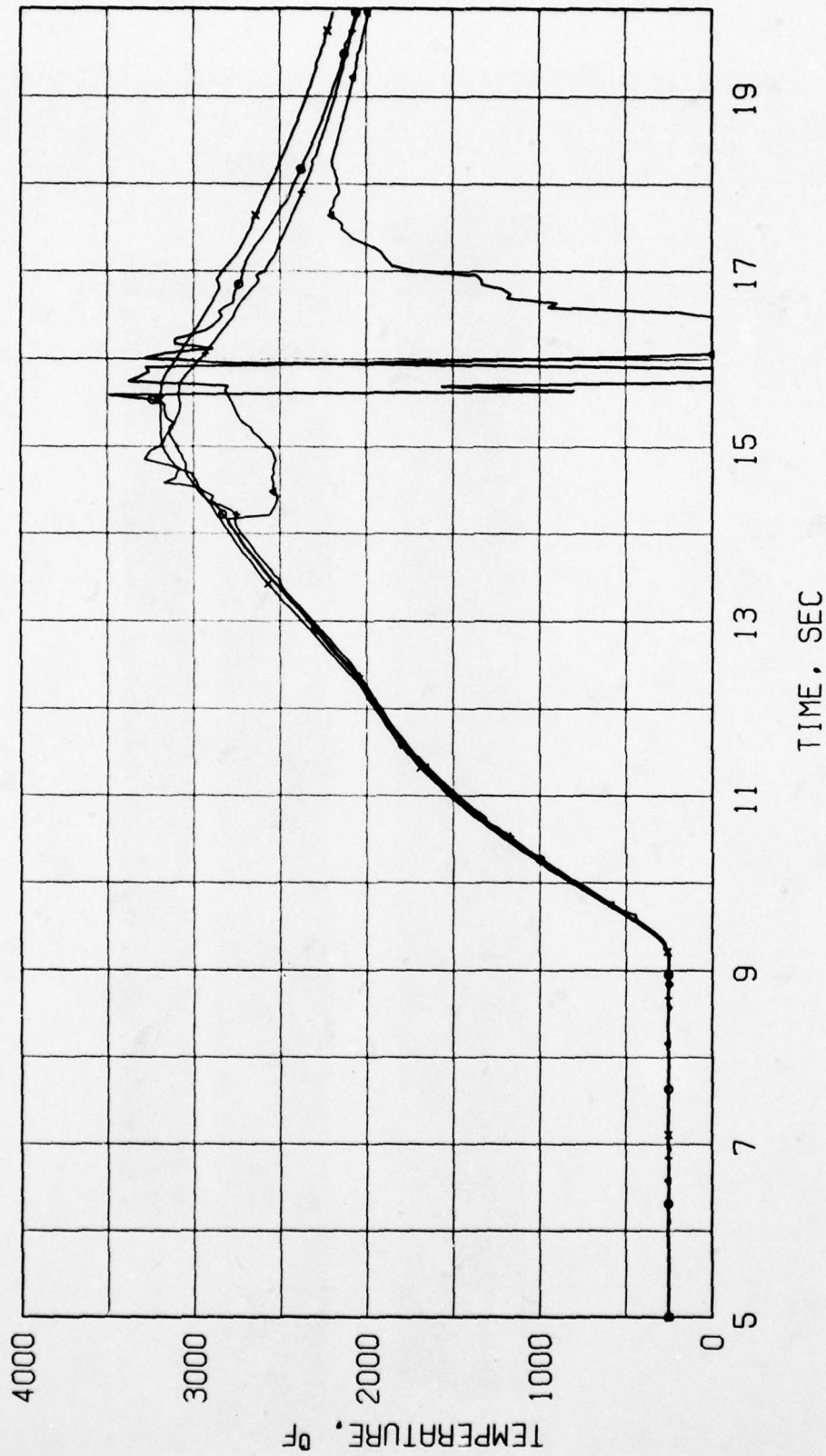




DATE 01-20-77 PRO INC
PROJ-P41E

PROJECT P41E TEST R0021 DATE 01-14-77 SEL 2107

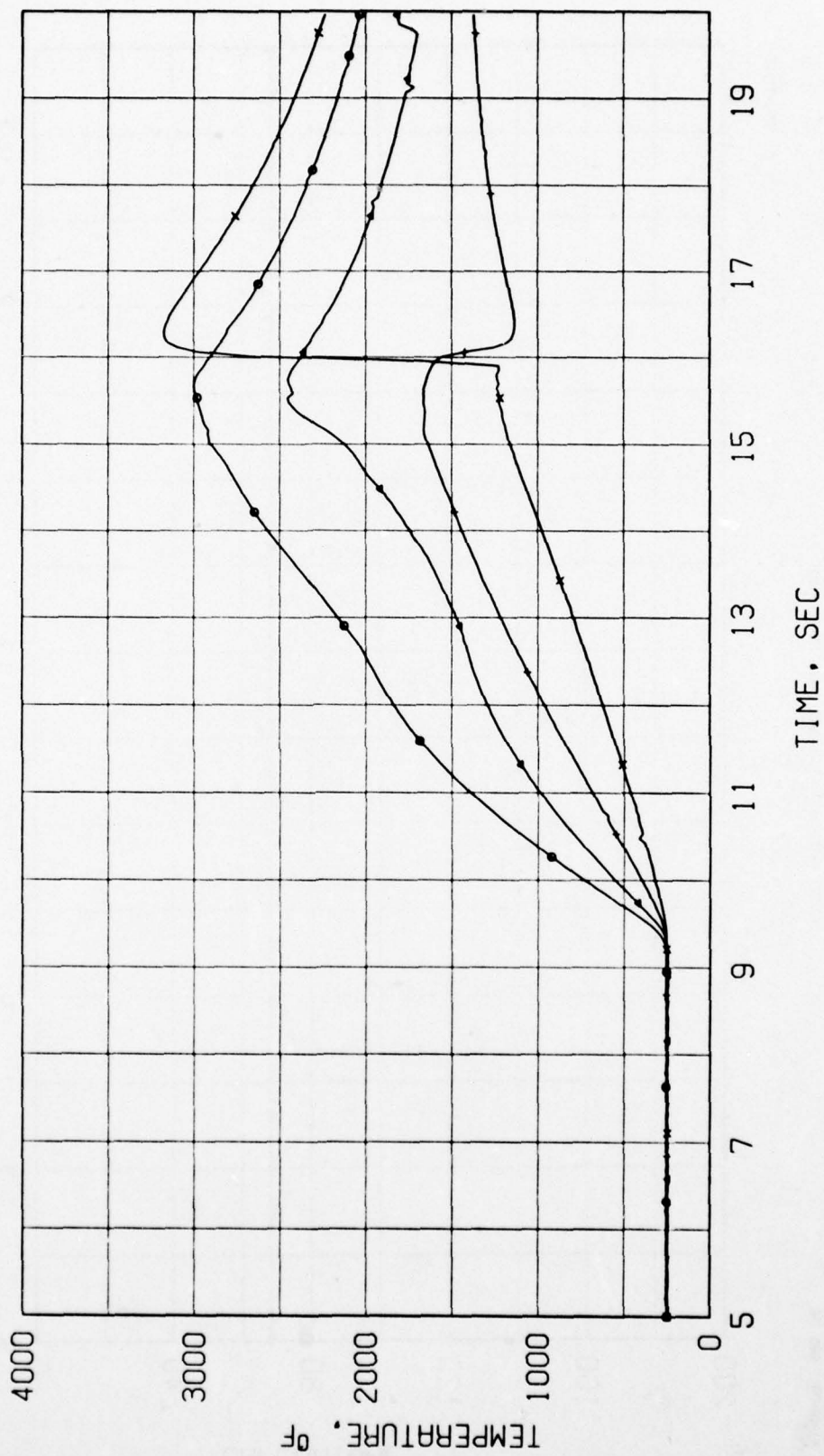
X TC-4-T1-22 + TC-3-T1-22 ▲ TC-2-T1-22 ○ TC-1-T1-22



DATE 01-20-77 RND INC
PROJ-P41E

PROJECT P41E TEST A0021 DATE 01-14-77 SEL 2107

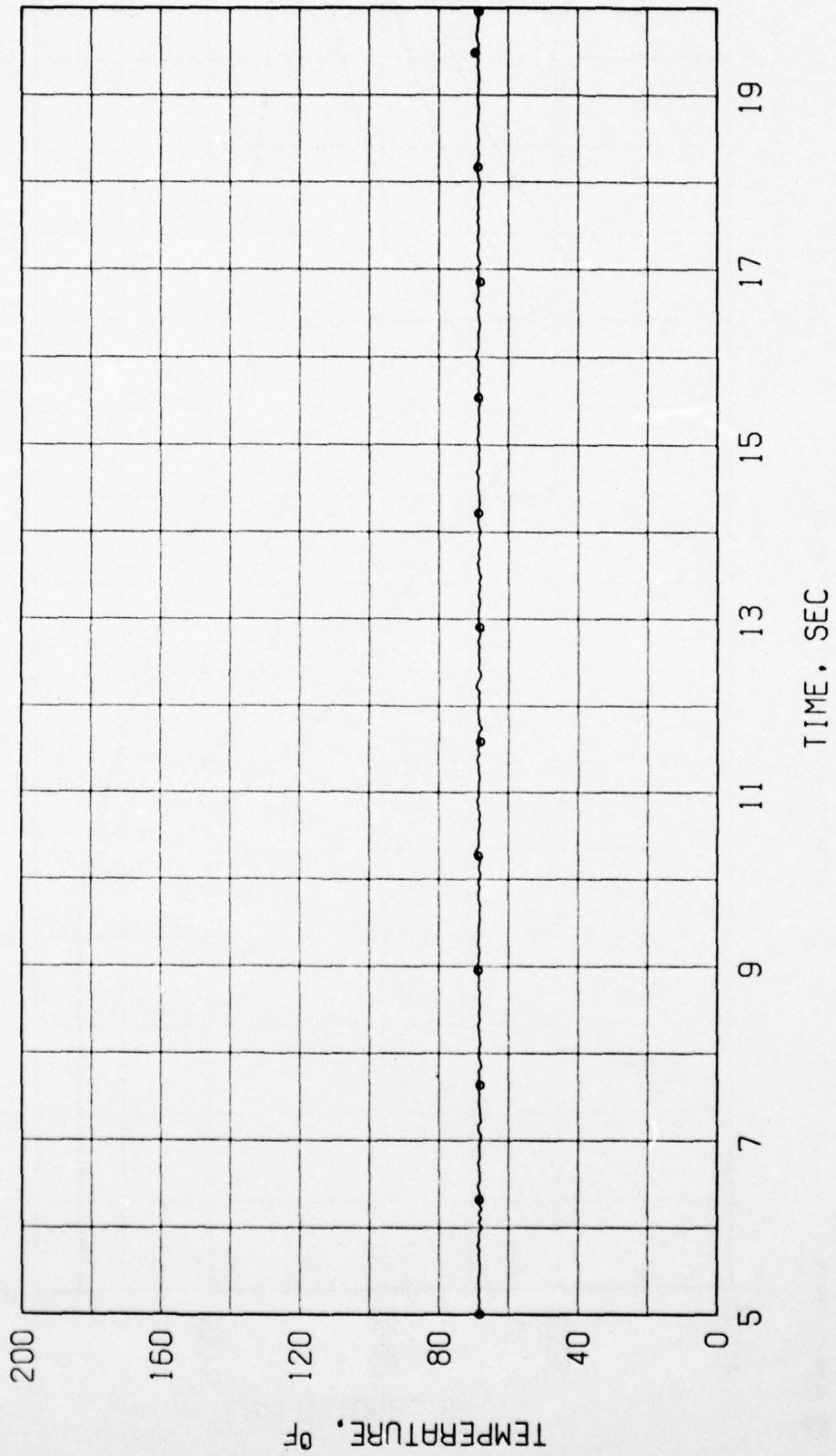
X TC-8-TI-22 + TC-7-TI-22 ▲ TC-6-TI-22 ○ TC-5-TI-22



DATE 01-20-77 PRO INC
PROJ-P41E

PROJECT P41E TEST R0021 DATE 01-14-77 SEL 2107

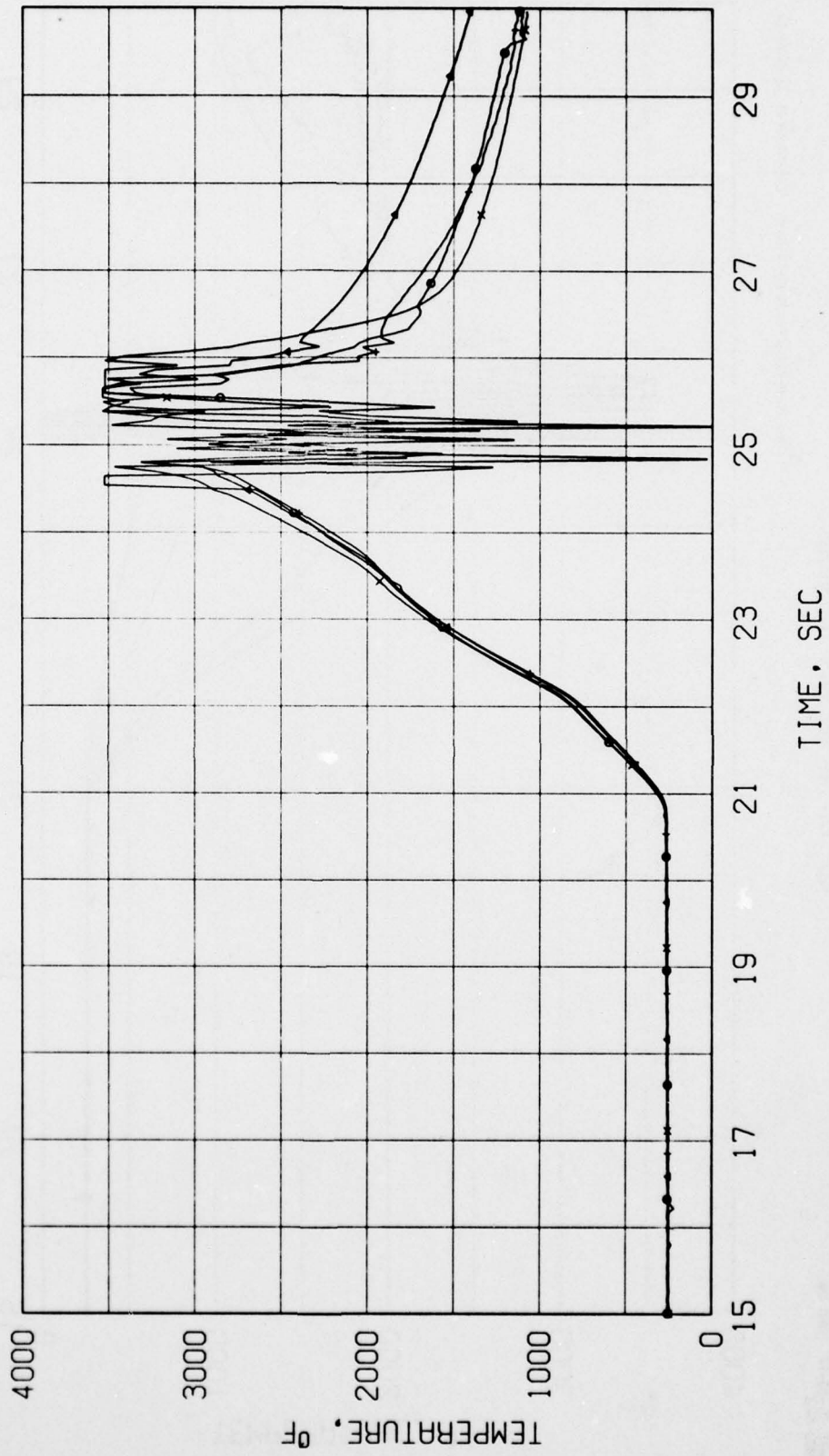
TC-9-T1-22



DATE 01-20-77 RRO INC
PROJ-P41E

PROJECT P41E TEST R0021 DATE 01-14-77 SEL 2107

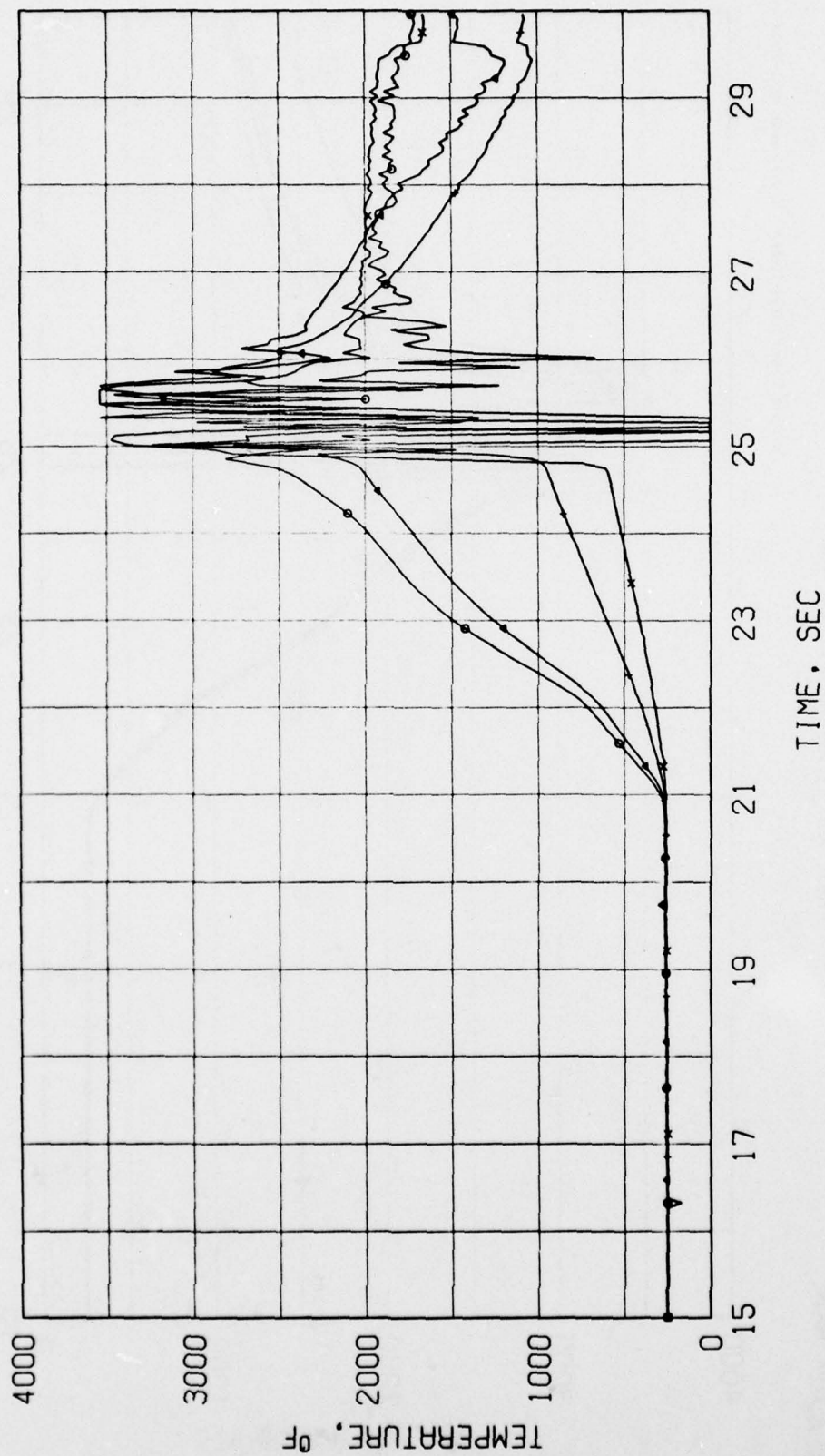
X TC-4-TI-S4 + TC-3-TI-S4 Δ TC-2-TI-S4 ○ TC-1-TI-S4



DATE 01-20-77 PRO INC
PROJ-P41E

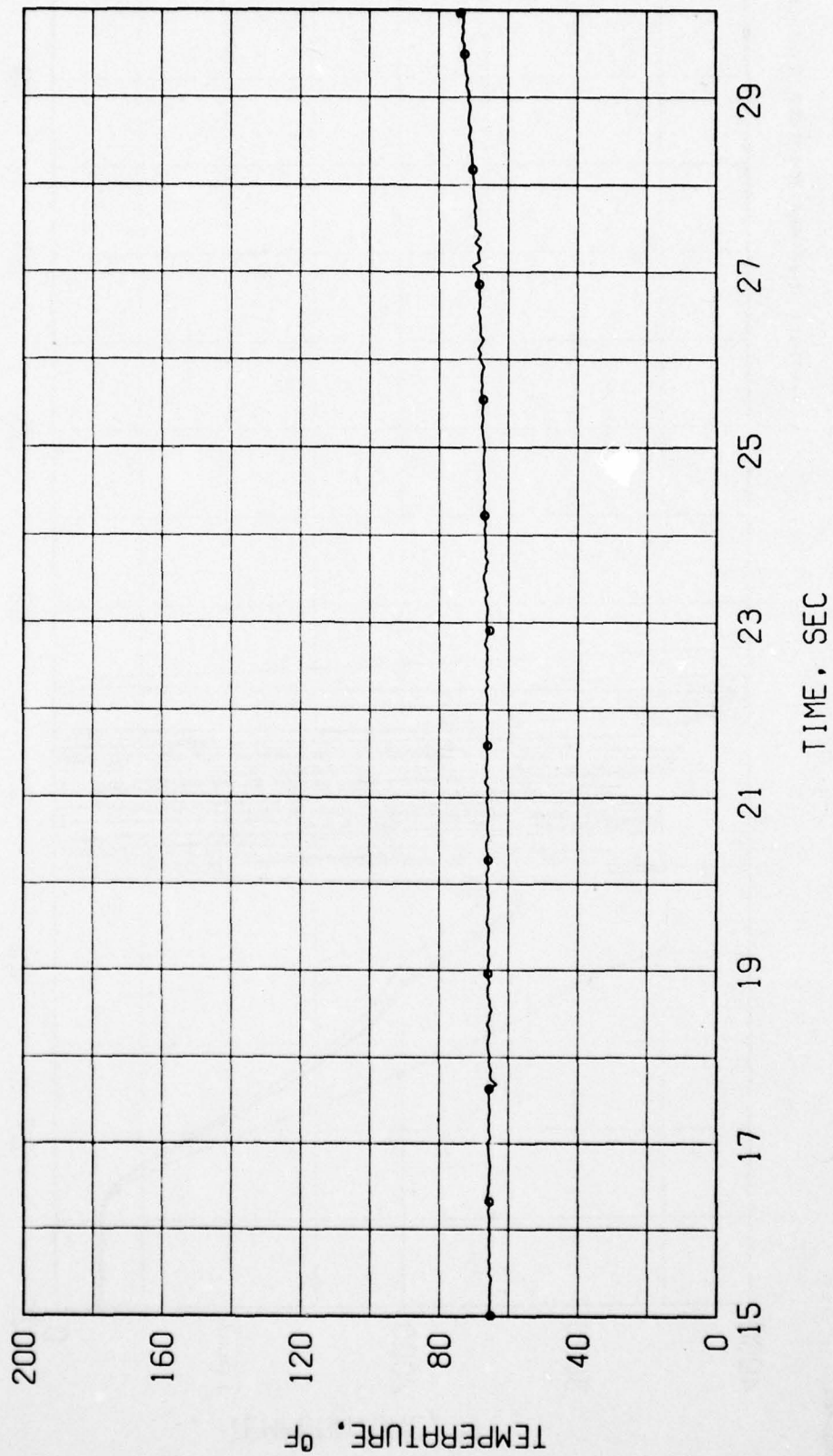
PROJECT P41E TEST R0021 DATE 01-14-77 SEL 2107

X TC-8-TI-54 + TC-7-TI-54 Δ TC-6-TI-54 ○ TC-5-TI-54



LCT P41E TEST #0021 DRIE 01-14-77 SEL 2107

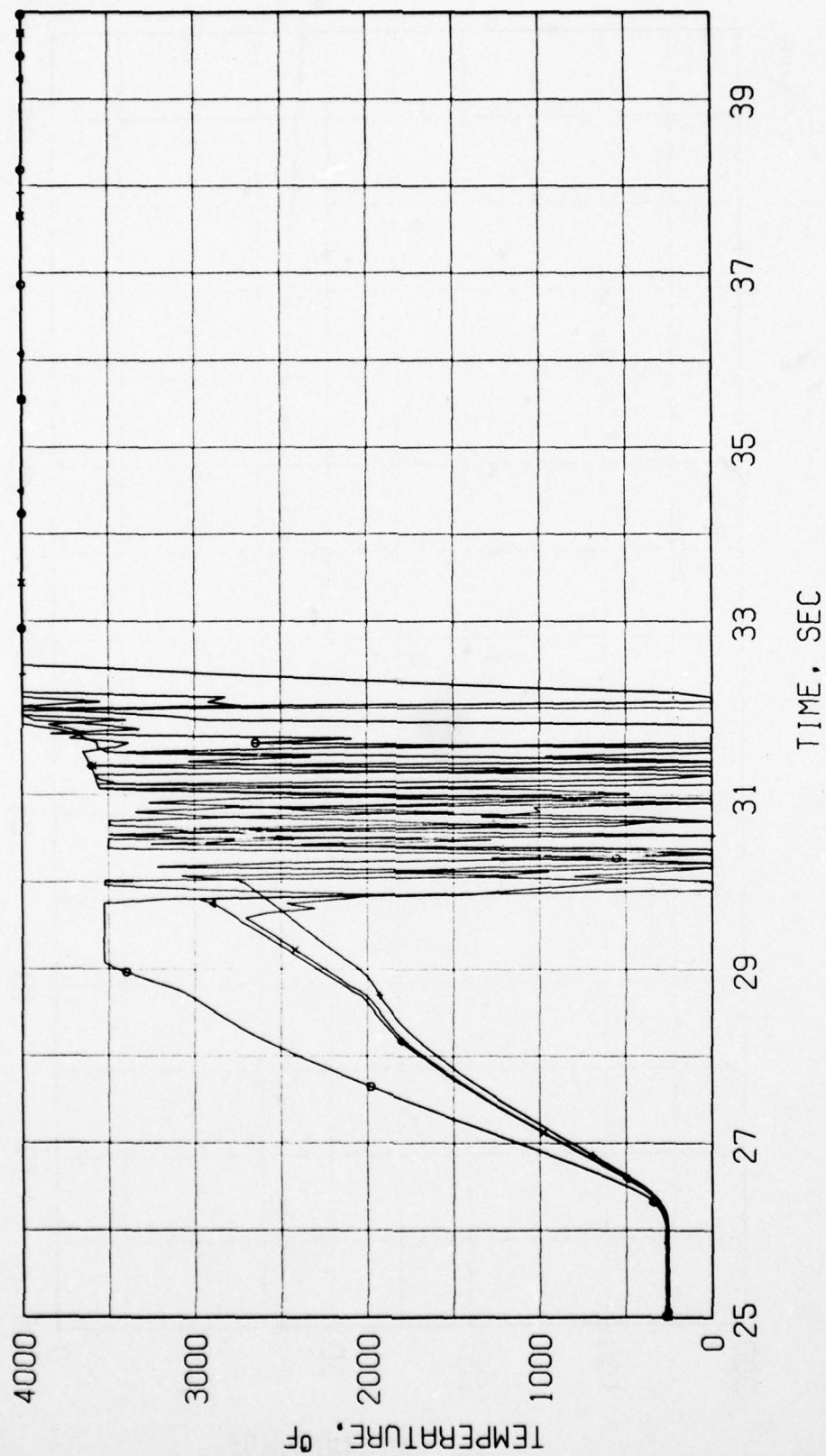
TC-9-11-54



DATE 01-20-77 PRO INC
PROJ-PAIE

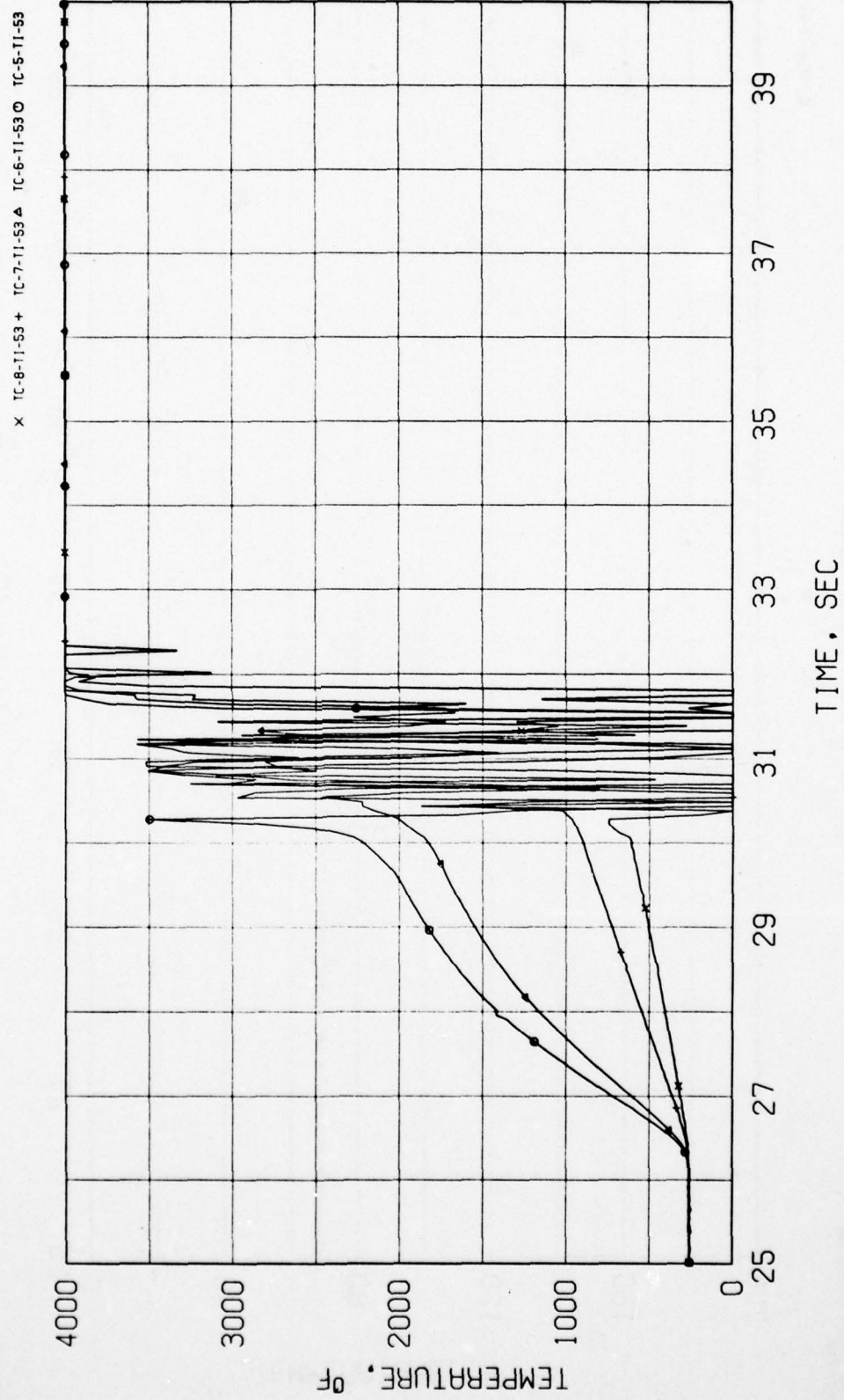
PROJECT PAIE TEST R0021 DATE 01-14-77 SEL 2107

X TC-4-T1-53 + TC-3-T1-53 ▲ TC-2-T1-53 ○ TC-1-T1-53



DATE 01-20-77 ARO INC
PROJ-P41E

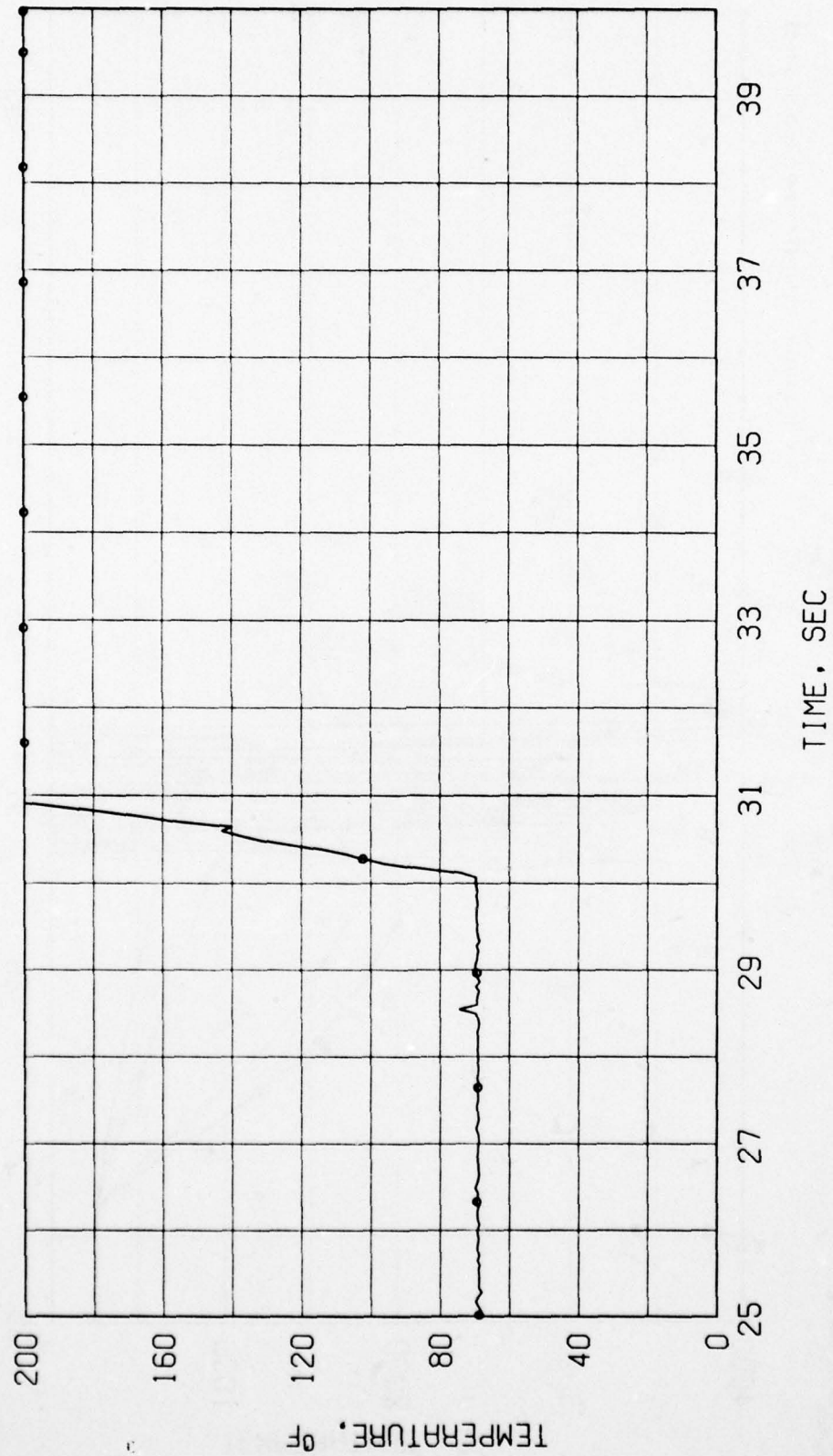
PROJECT P41E TEST R0021 DATE 01-14-77 SEL 2107



DATE 01-20-77 RAO INC
PROJ-P41E

PROJECT P41E TEST R0021 DATE 01-14-77 SEL 2107

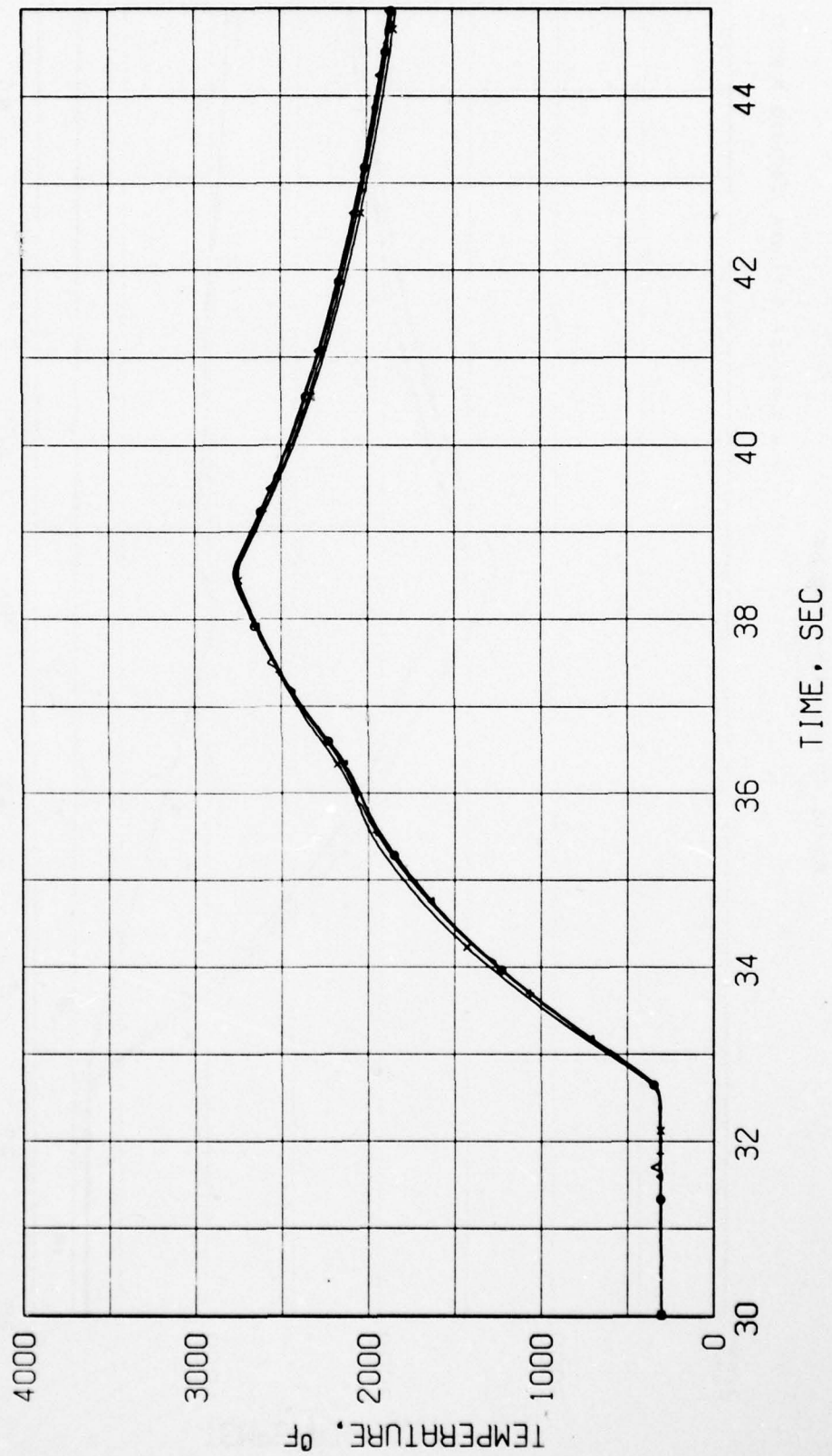
TC-9-T1-53



DATE 01-20-77 RRD INC
PROJ-P41E

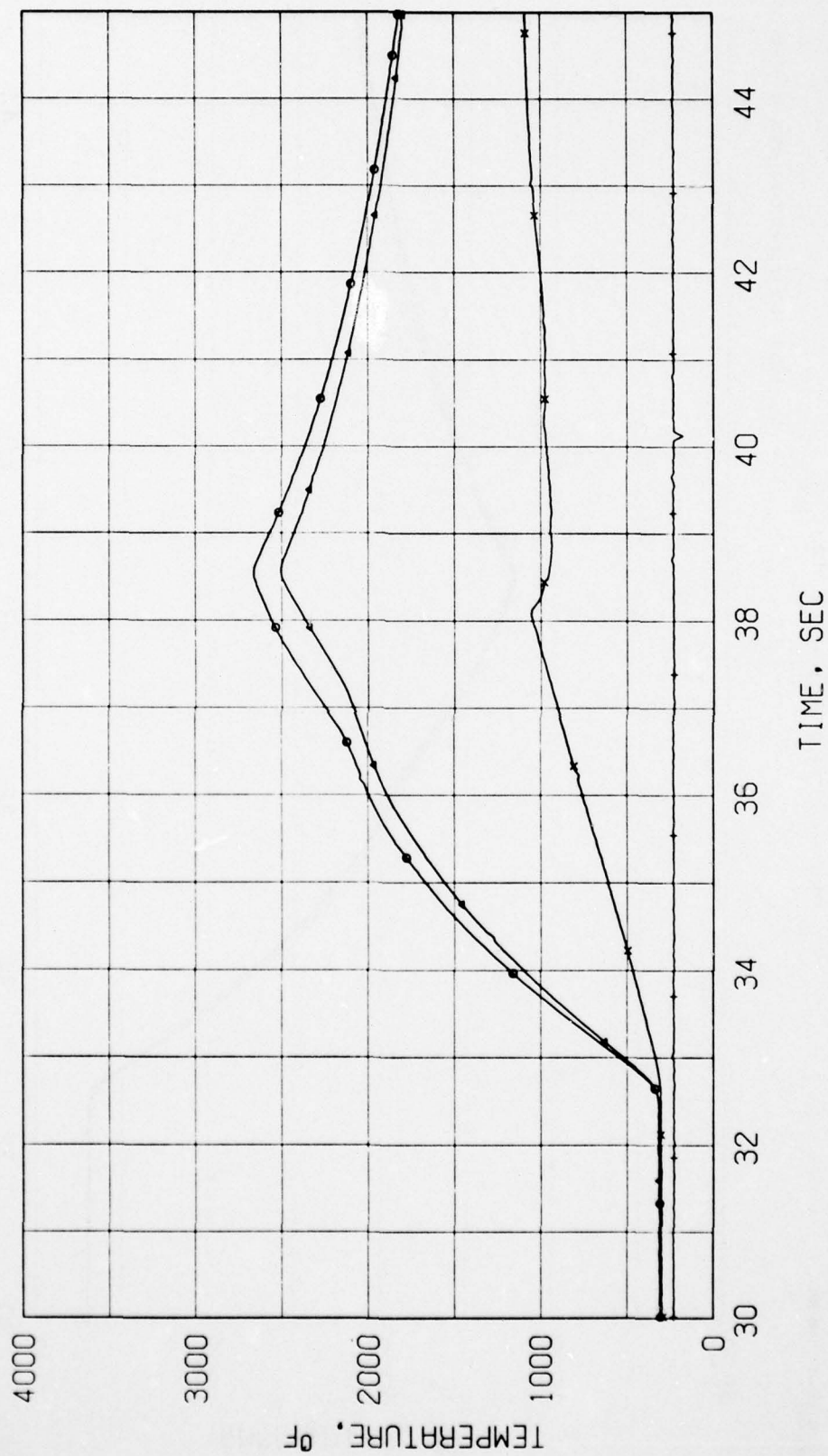
PROJECT P41E TEST A0021 DATE 01-14-77 SEL 2107

X TC-4-T1-23 + TC-3-T1-23 ▲ TC-2-T1-23 ○ TC-1-T1-23



JECT PAIE TEST HQ021 DATE 01-14-77 SEL 2107

X TC-8-TI-23 + TC-7-TI-23 Δ TC-6-TI-23 ○ TC-5-TI-23

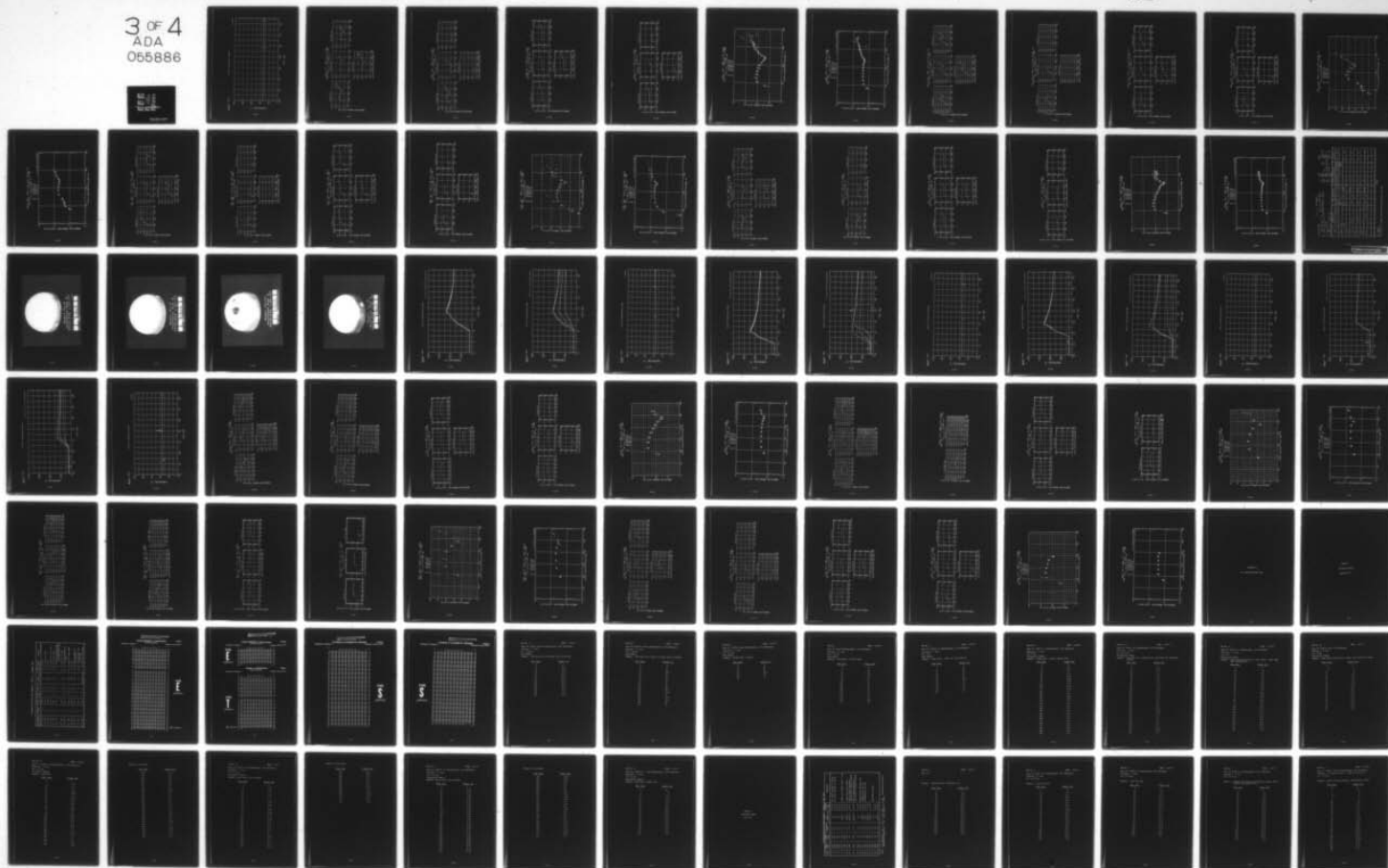


AD-A055 886

SCIENCE APPLICATIONS INC EL SEGUNDO CALIF
TITANIUM RESPONSE TO SIMULATED NUCLEAR CLOUD PARTICLE ENVIRONME--ETC(U)
AUG 77 L E DUNBAR, R M CLEVER, G H BURGHART DNA001-76-C-0366
SAI-78-561-LA-VOL-2 DNA-4404F-2 NL

UNCLASSIFIED

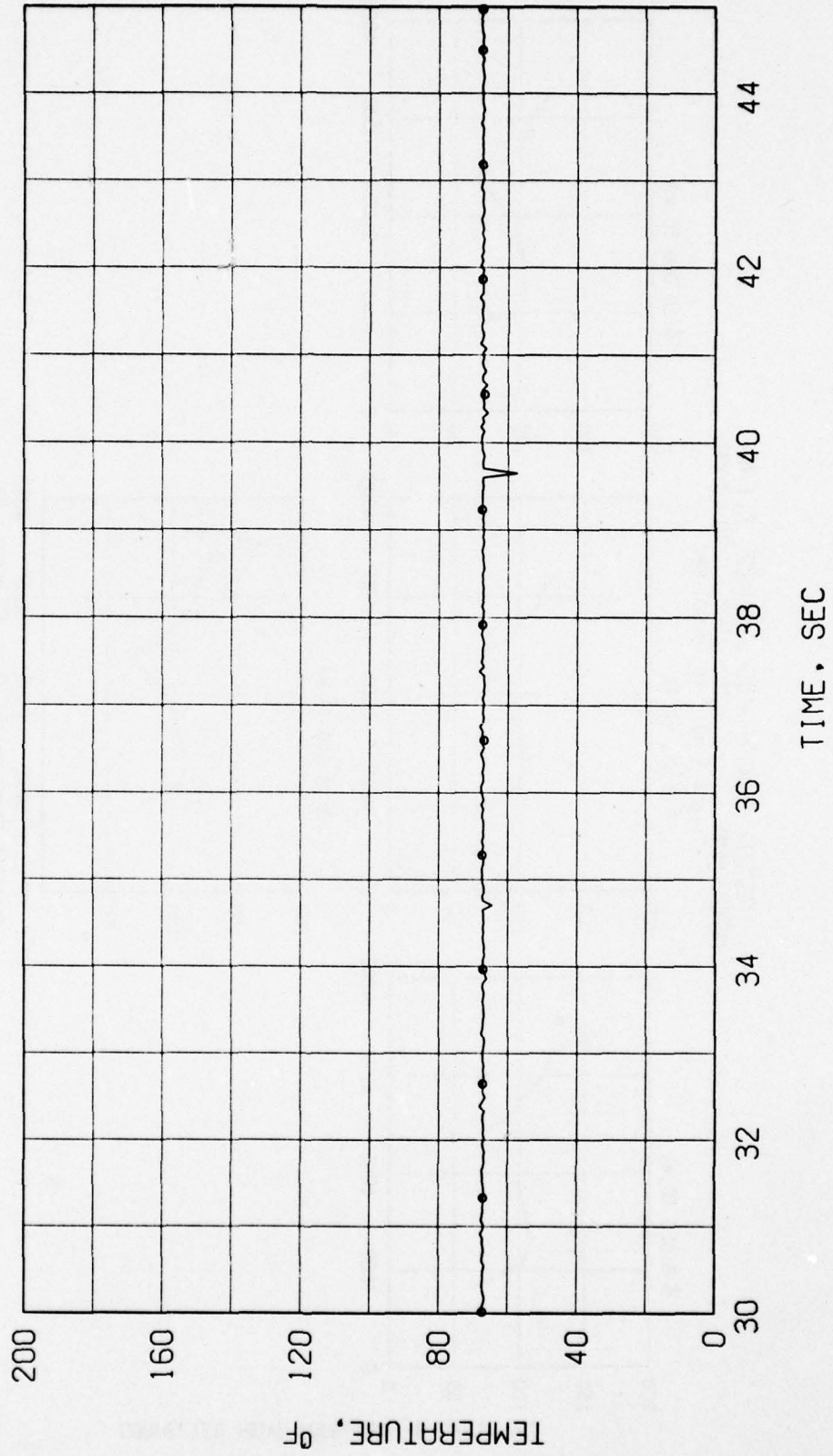
3 OF 4
ADA
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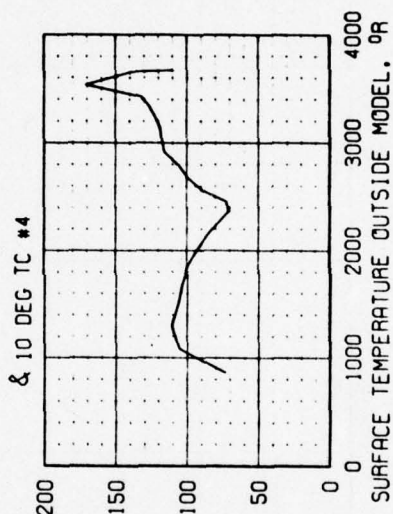
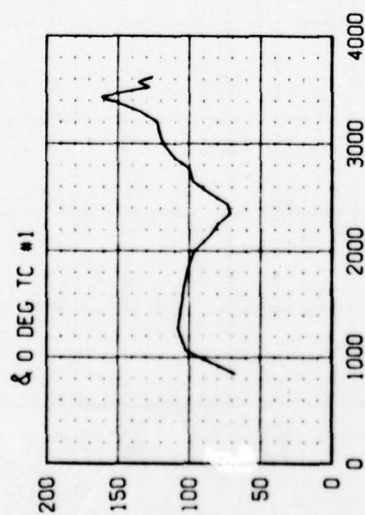
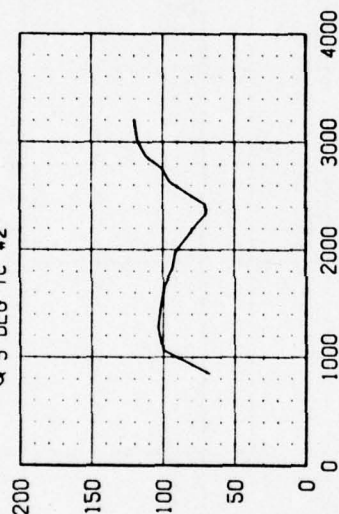
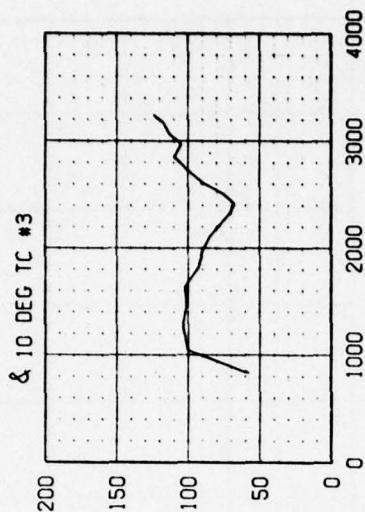
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PROJ-P41E

PROJECT P41E TEST R0021 DATE 01-14-77 SEL 2107

TC-9-T1-23



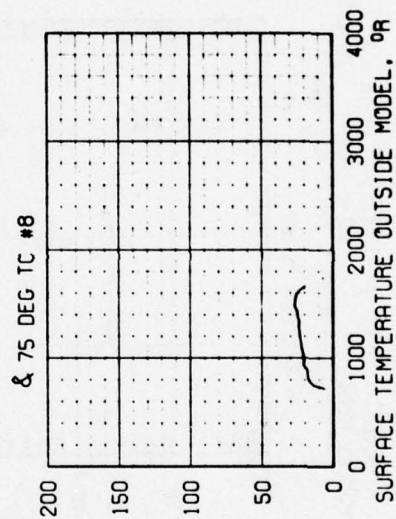
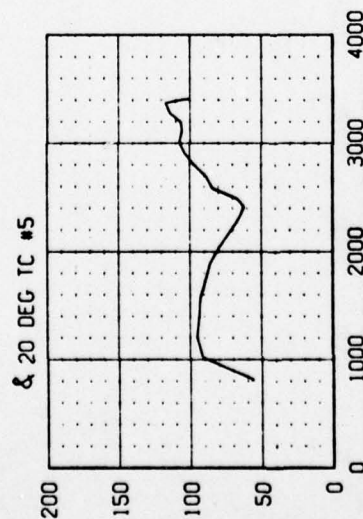
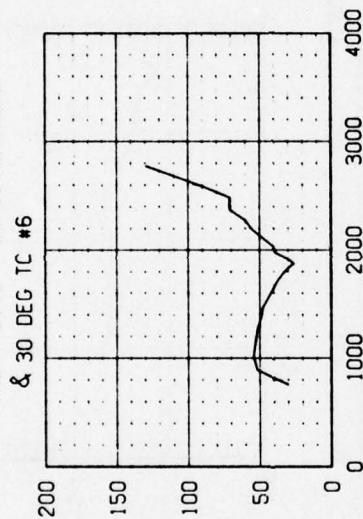
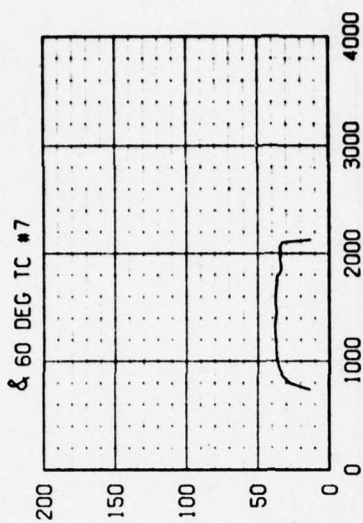
AD021 RUN 7 MODEL TI-22 CLEAR
 MODEL HEMI P0 = 1002 T0 = 5900
 Time = 9.43 to 15.60 Sec



CORRECTED HEAT TRANSFER, BTU/FT² SEC

SURFACE TEMPERATURE OUTSIDE MODEL, °R

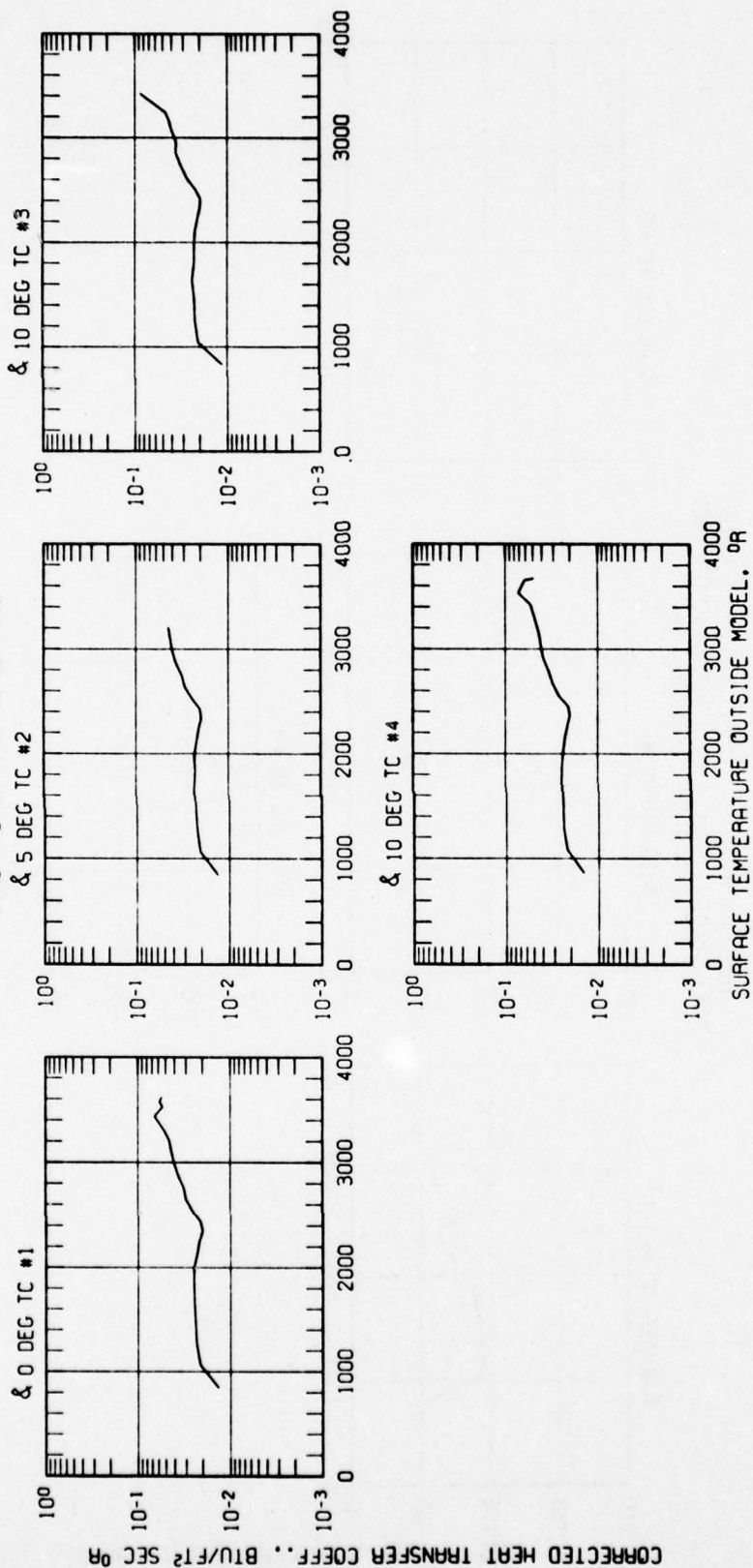
AD021 RUN 7 MODEL T1-22 CLEAR
 MODEL HEMI P0 = 1002 T0 = 5900
 Time = 9.43 to 15.60 Sec



CORRECTED HEAT TRANSFER, BTU/FT² SEC

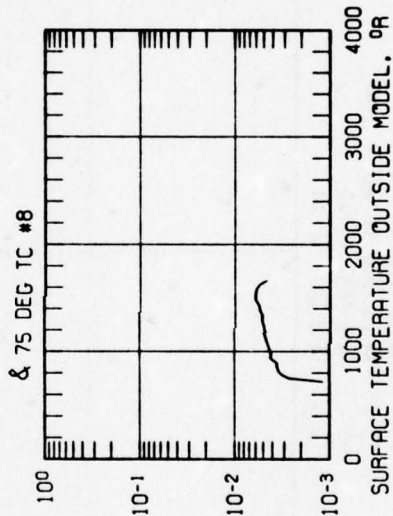
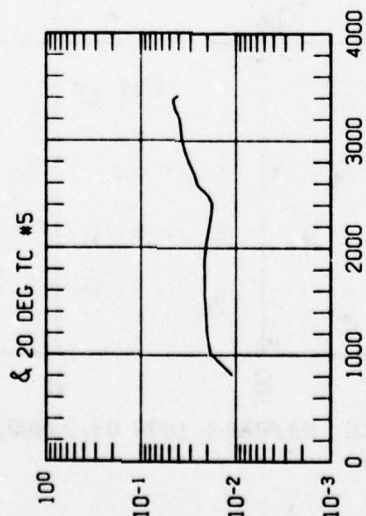
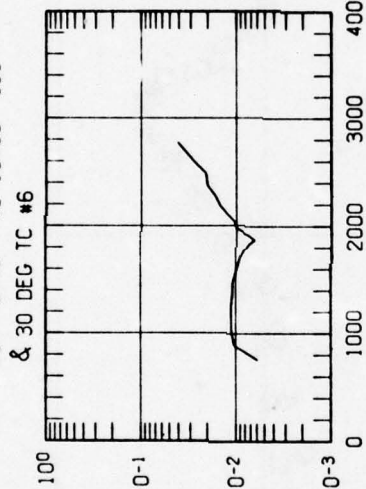
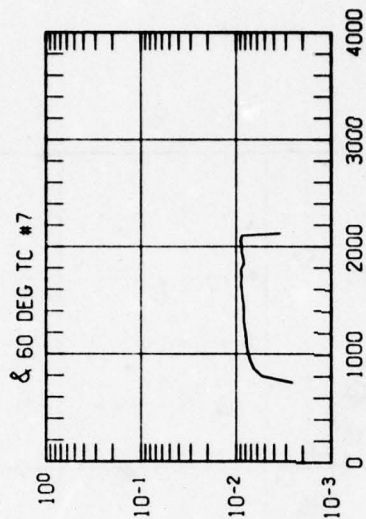
SURFACE TEMPERATURE OUTSIDE MODEL, °R

AD021 RUN 7 MODEL T1-22 CLEAR
 MODEL HEMI P0 = 1002 T0 = 5900
 Time = 9.43 to 15.60 Sec



CORRECTED HEAT TRANSFER COEFF., BTU/FT² SEC °R

AD021 RUN 7 MODEL T1-22 CLEAR
 MODEL HEMI P0 = 1002 T0 = 5900
 Time = 9.43 to 15.60 Sec

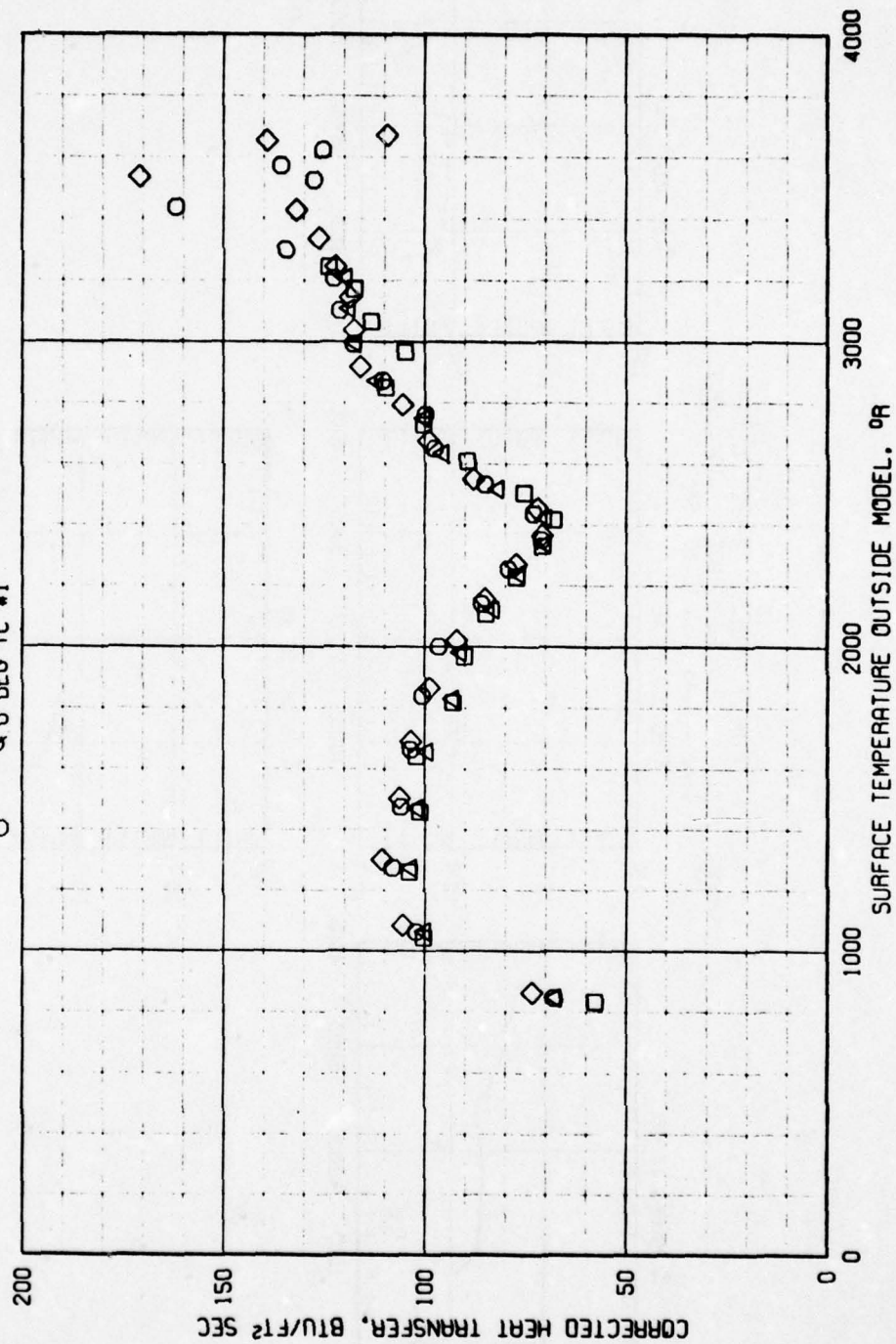


CORRECTED HEAT TRANSFER COEFF., BTU/FT² SEC °R

SURFACE TEMPERATURE OUTSIDE MODEL, °R

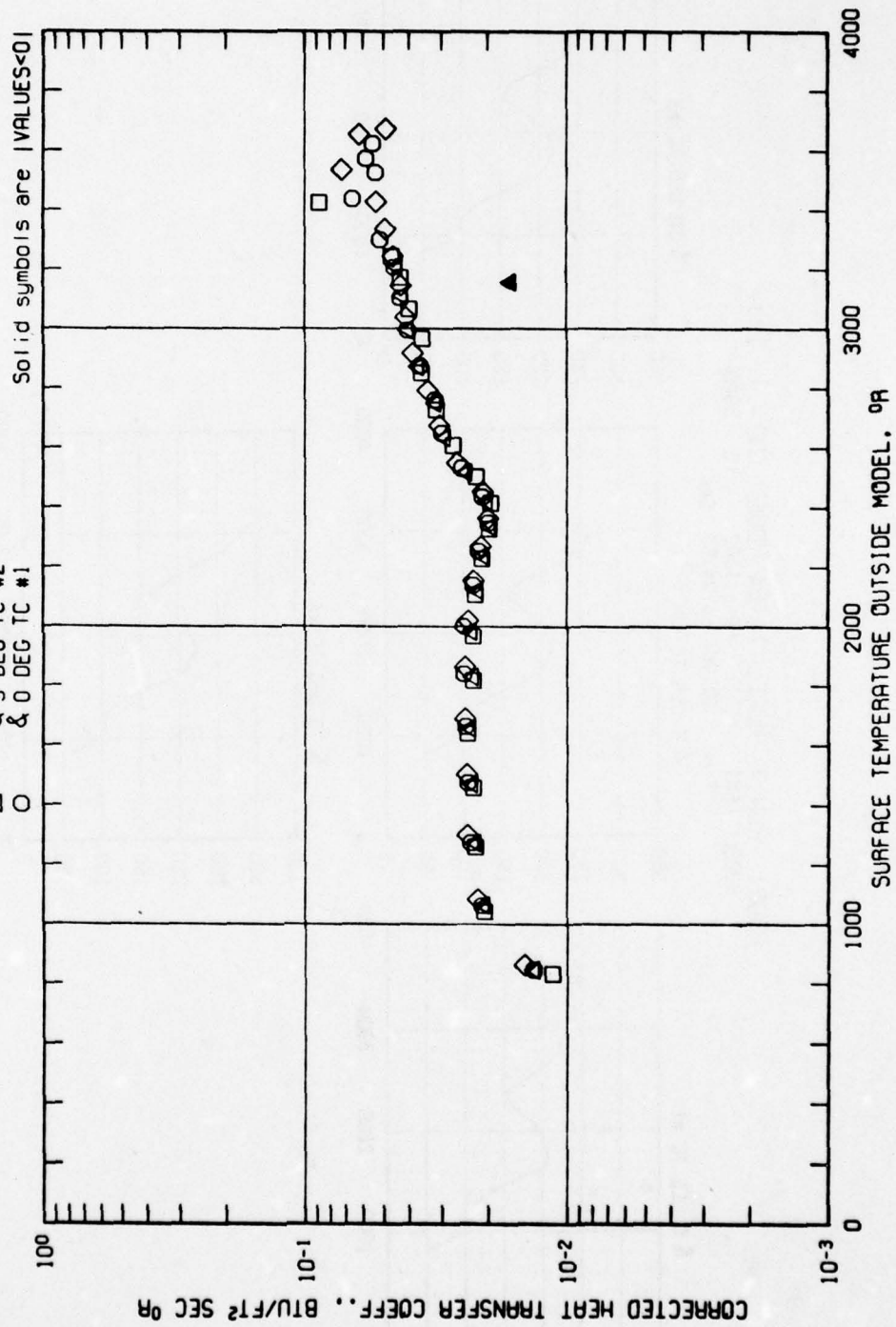
AD021 RUN 7 MODEL TI-22 CLEAR
 MODEL HEMI PO = 1002 TO = 5900
 Time = 9.43 to 15.60 Sec

◇ & 10 DEG TC #4
 □ & 10 DEG TC #3
 △ & 5 DEG TC #2
 ○ & 0 DEG TC #1

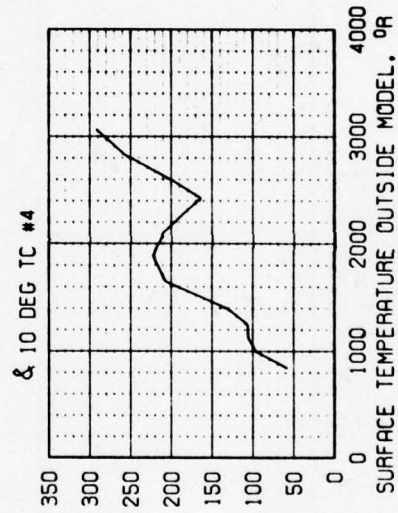
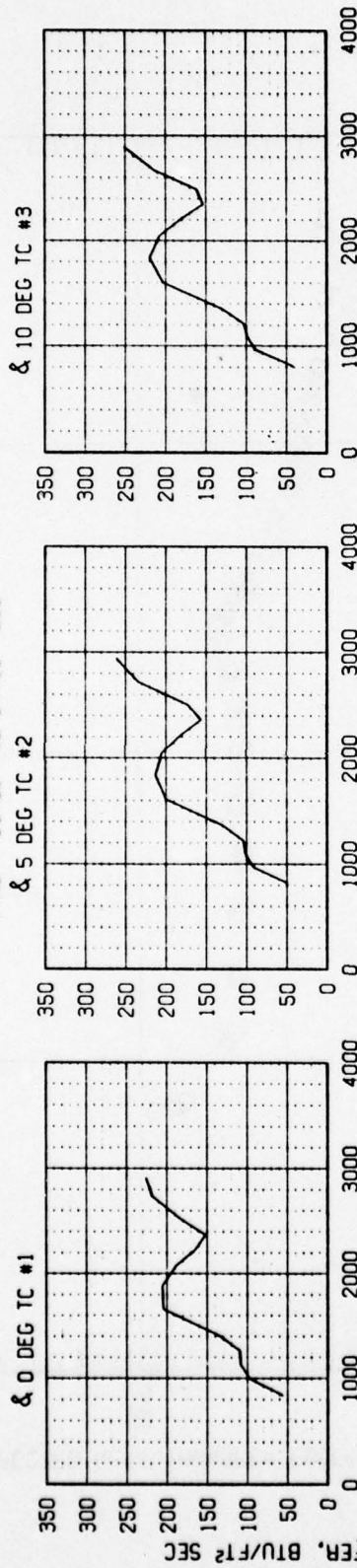


AD021 RUN 7 MODEL TI-22 CLEAR
 MODEL HEMI PO = 1002 TO = 5900
 Time = 9.43 to 15.60 Sec

◇ 10 DEG TC #4
 □ 10 DEG TC #3
 △ 5 DEG TC #2
 ○ 0 DEG TC #1

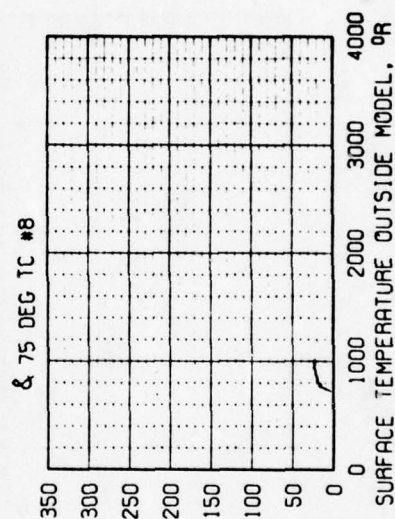
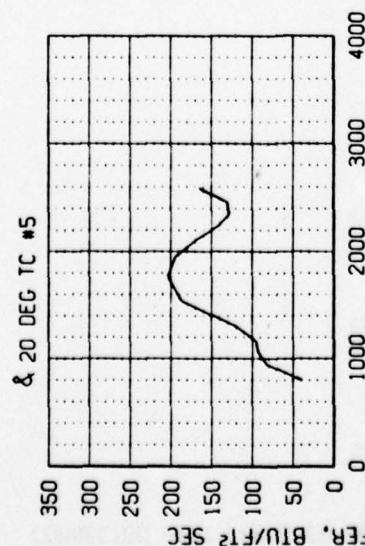
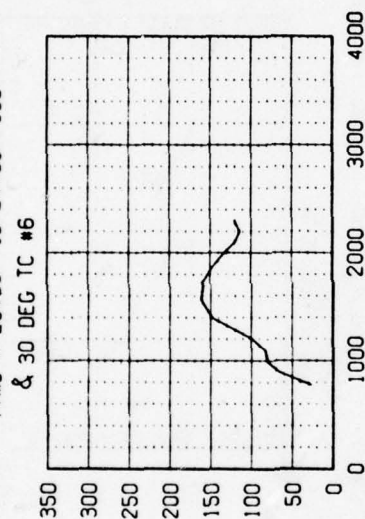
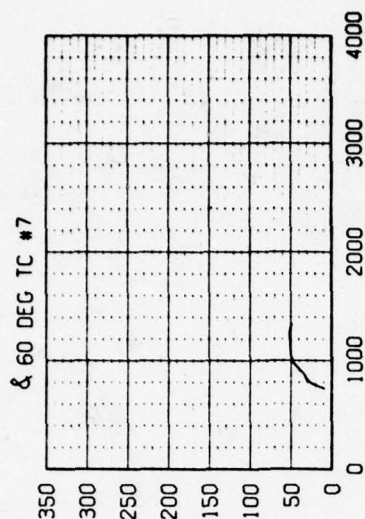


AD021 RUN 7 MODEL T1-54 DUST (NO CH. 13)
 MODEL HEMI PO = 1002 TO = 5900
 Time = 20.96 to 24.50 Sec



CORRECTED HEAT TRANSFER, BTU/FT² SEC

AD0021 RUN 7 MODEL TI-54 DUST (NO CH. 13)
 MODEL HEMI P0 = 1002 T0 = 5900
 Time = 20.96 to 24.50 Sec



CORRECTED HEAT TRANSFER, BTU/FT² SEC

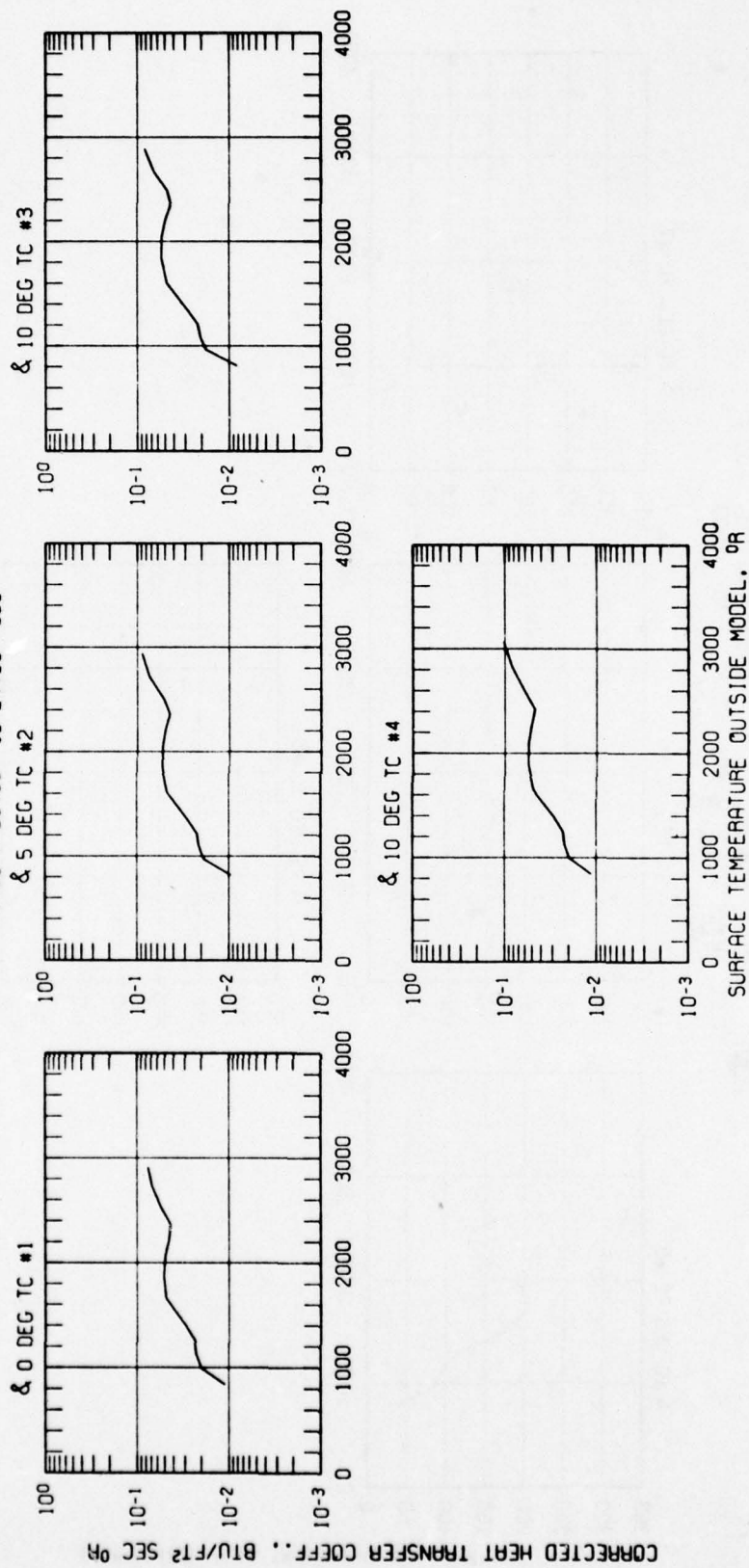
SURFACE TEMPERATURE OUTSIDE MODEL, °R

AD021 RUN 7 MODEL TI-54 DUST (NO CH. 13)

MODEL HEMI

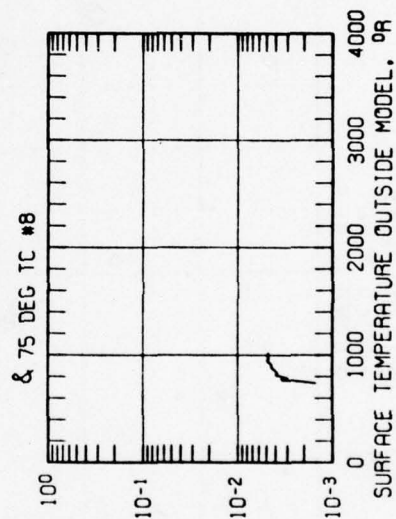
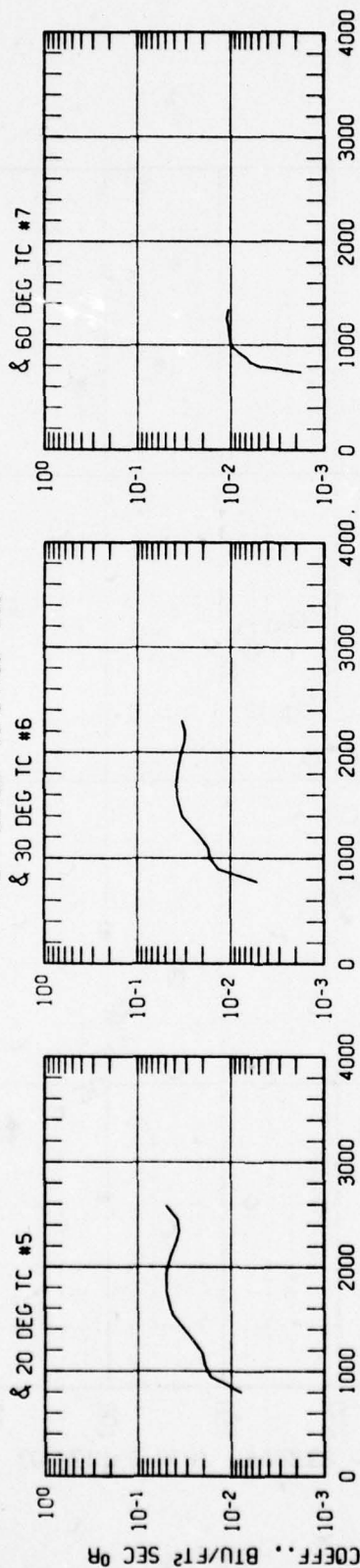
P0 = 1002 T0 = 5900

Time = 20.96 to 24.50 Sec



CORRECTED HEAT TRANSFER COEFF., BTU/FT² SEC °R

AD021 RUN 7 MODEL TI-54 DUST (NO CH. 13)
 MODEL HEMI P0 = 1002 T0 = 5900
 Time = 20.96' to 24.50 Sec



CORRECTED HEAT TRANSFER COEFF., BTU/FT² SEC OR

SURFACE TEMPERATURE OUTSIDE MODEL, OR

AD021 RUN 7 MODEL TI-54 DUST (NO CH. 13)

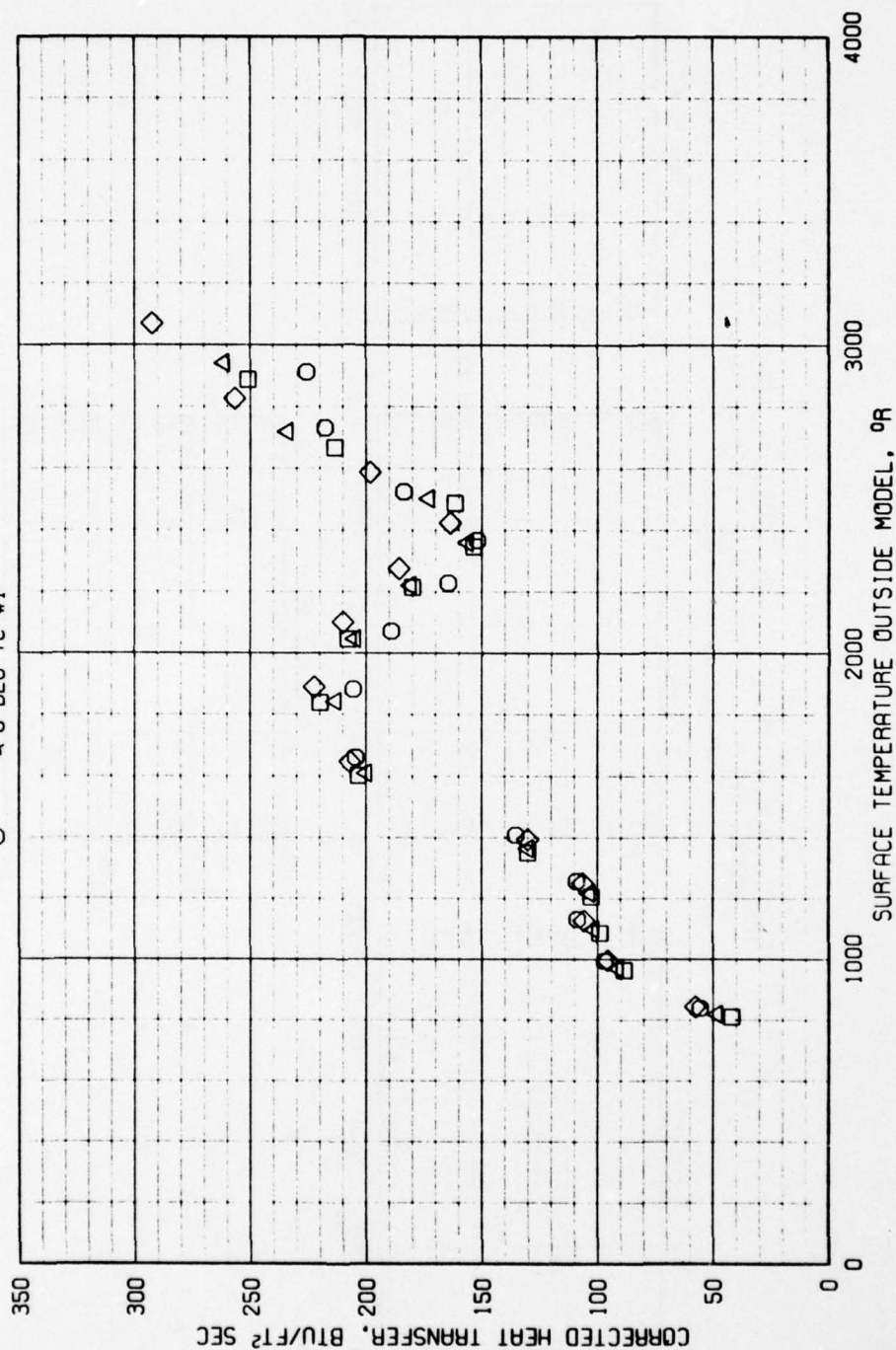
MODEL HEMI

P0 = 1002

T0 = 5900

Time = 20.96 to 24.50 Sec

◇ & 10 DEG TC #4
 □ & 10 DEG TC #3
 △ & 5 DEG TC #2
 ○ & 0 DEG TC #1

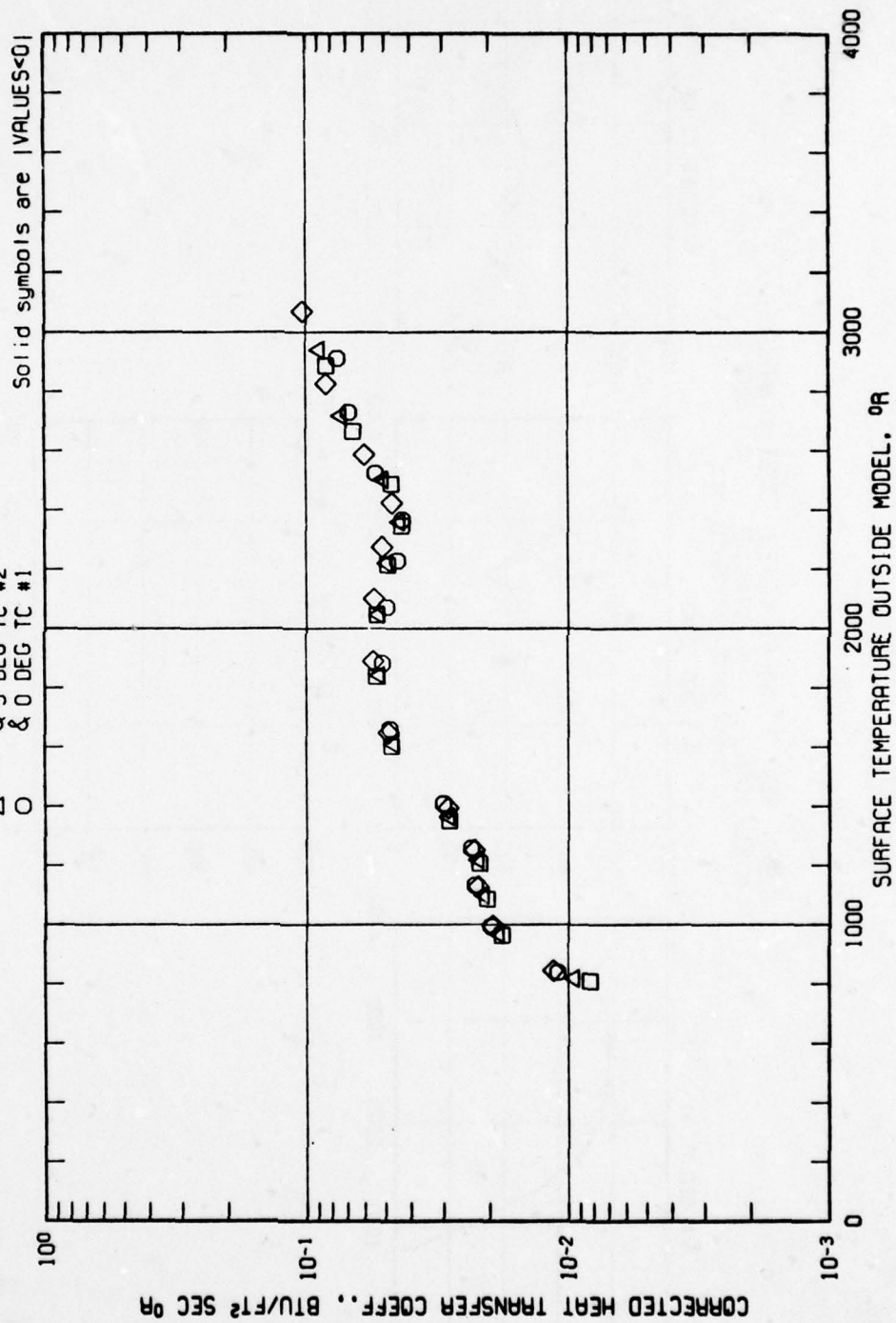


AD021 RUN 7 MODEL TI-54 DUST (NO CH. 13)

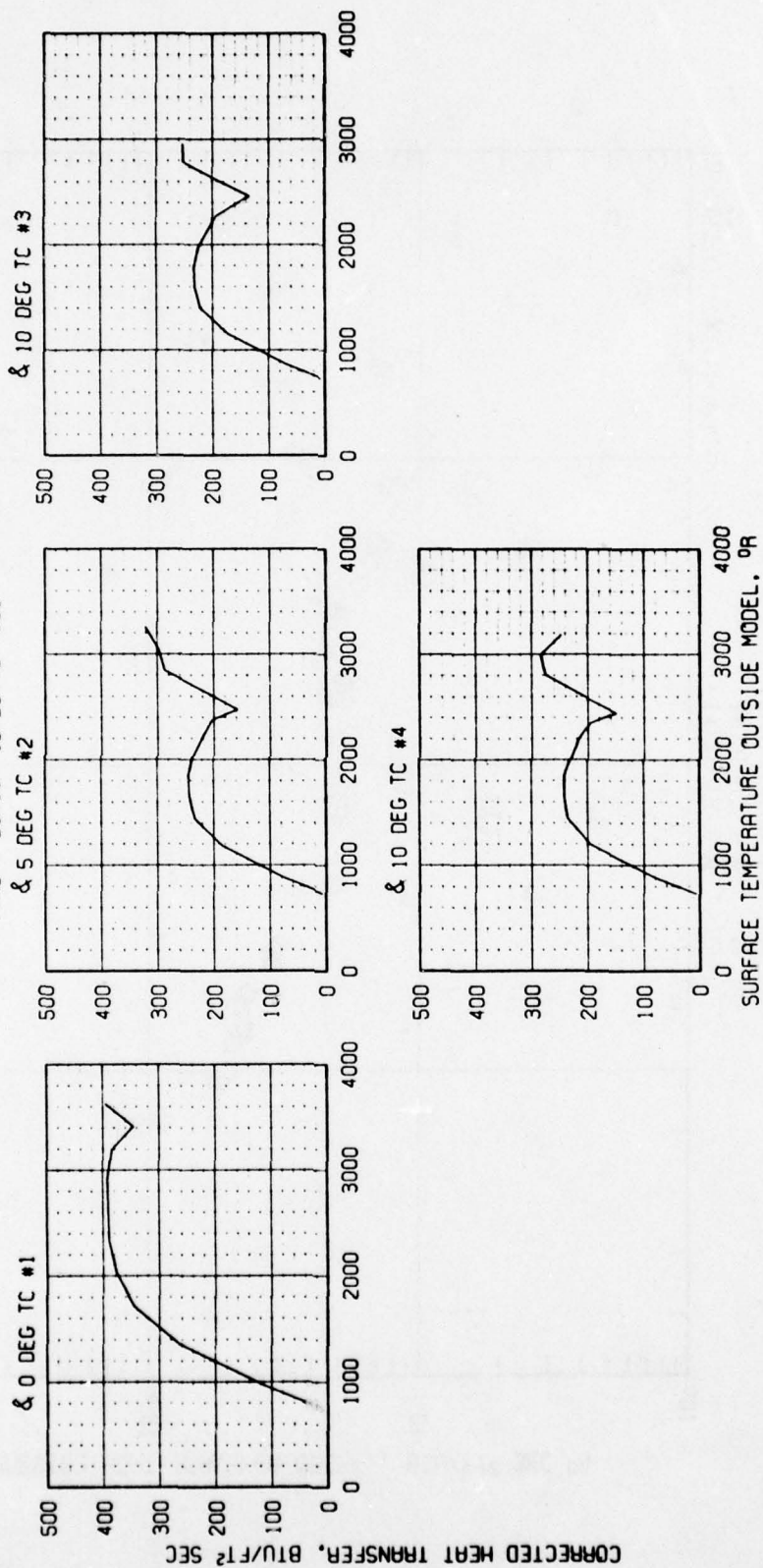
MODEL HEMI P0 = 1002 T0 = 5900

Time = 20.96 to 24.50 Sec

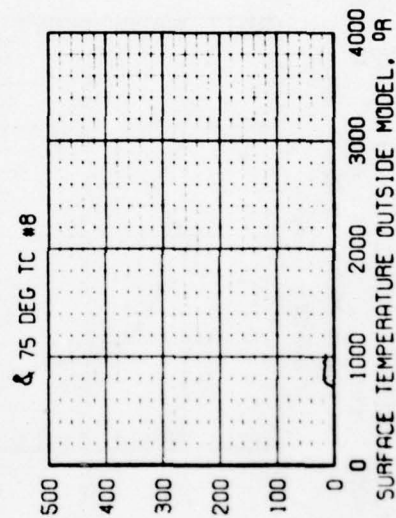
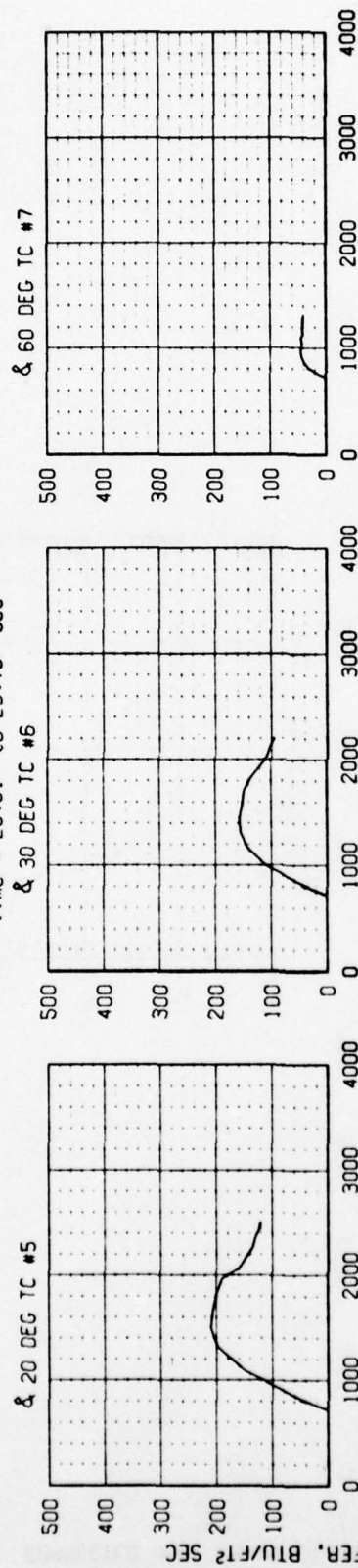
◇ & 10 DEG TC #4
 □ & 10 DEG TC #3
 △ & 5 DEG TC #2
 ○ & 0 DEG TC #1



AD02: RUN 7 MODEL TI-53 DUST + WATER
 MODEL HEMI P0 = 1002 T0 = 5900
 Time = 26.01 to 29.70 Sec

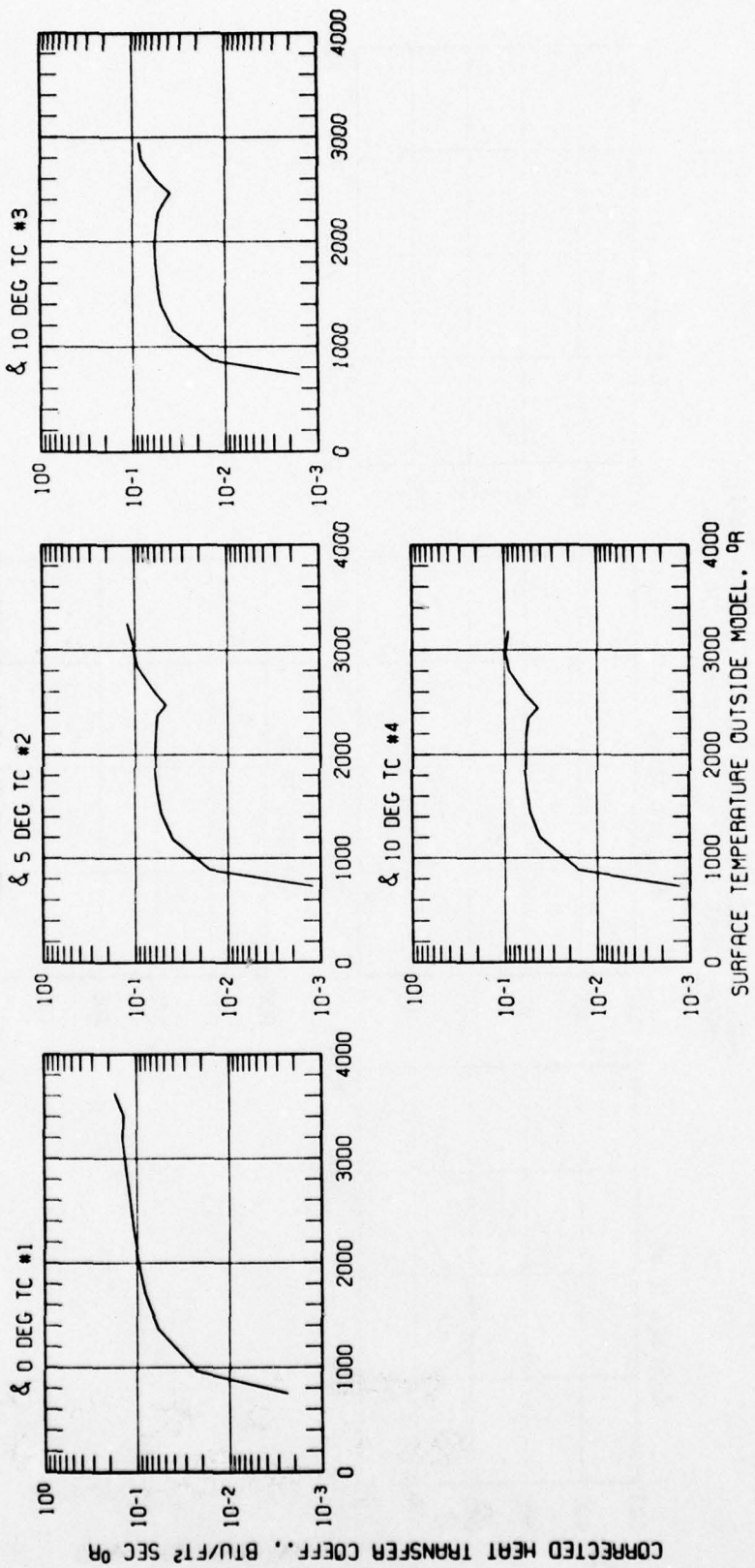


AD021 RUN 7 MODEL TI-53 DUST + WATER
 MODEL HEMI P0 = 1002 T0 = 5900
 Time = 26.01 to 29.70 Sec

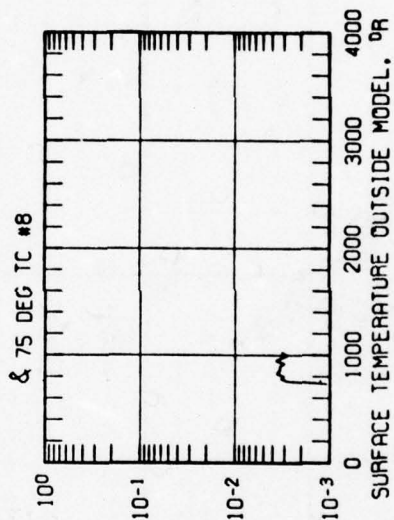
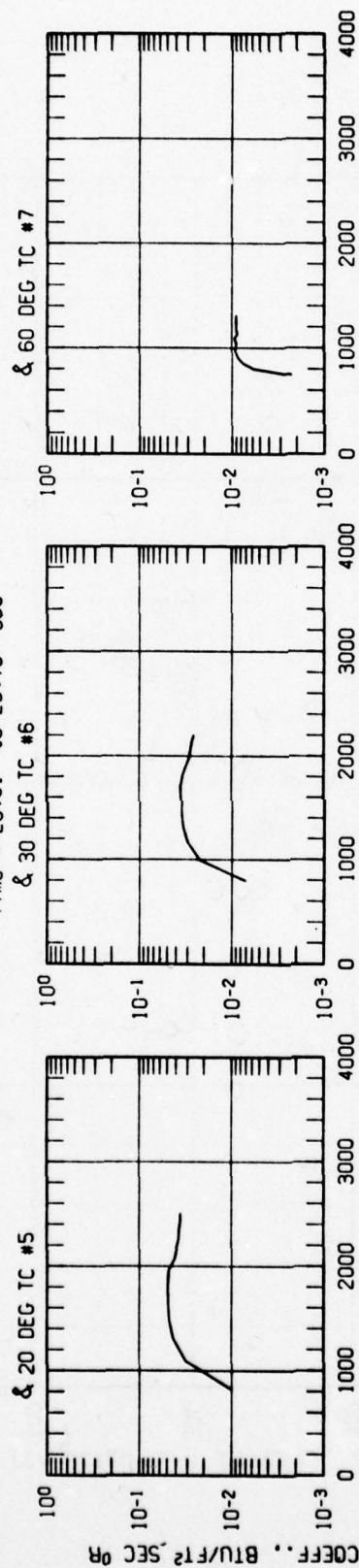


SURFACE TEMPERATURE OUTSIDE MODEL, °R

time = 26.01 to 29.70 Sec



AD021 RUN 7 MODEL T1-53 DUST + WATER
 MODEL HEMI P0 = 1002 T0 = 5900
 Time = 26.01 to 29.70 Sec

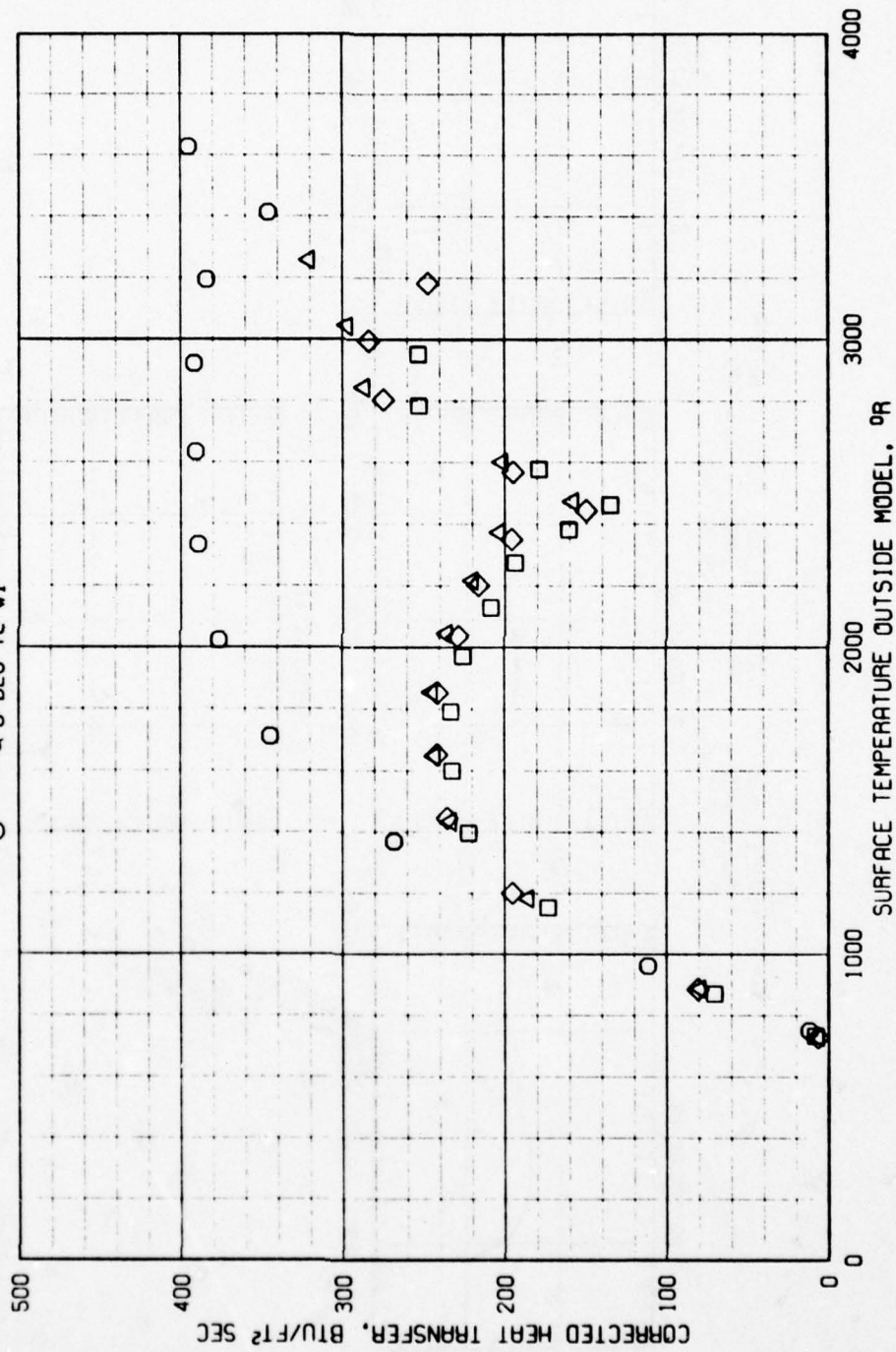


CORRECTED HEAT TRANSFER COEFF., BTU/FT² SEC °R

SURFACE TEMPERATURE OUTSIDE MODEL, °R

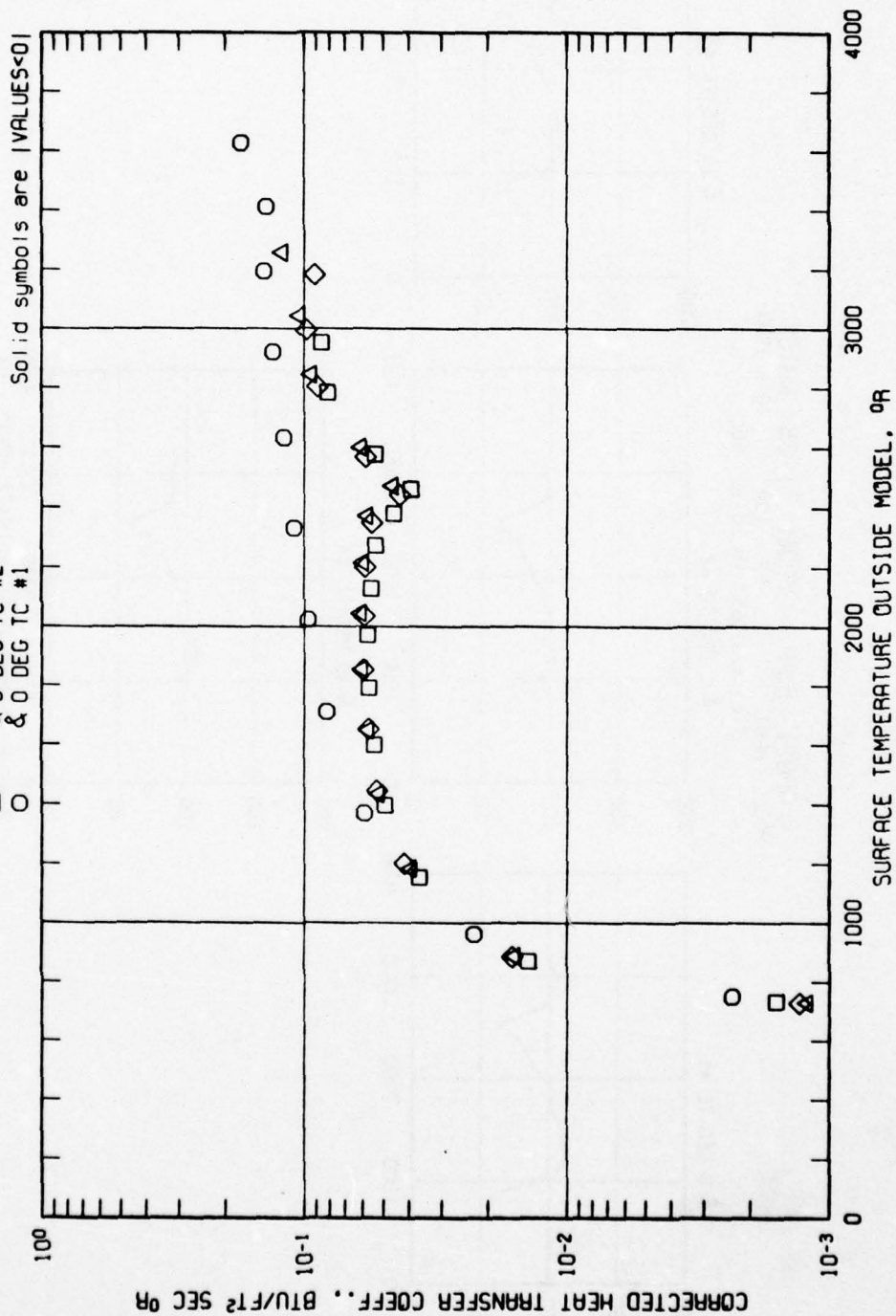
AD021 RUN 7 MODEL T1-53 DUST + WATER
 MODEL HEMI P0 = 1002 T0 = 5900
 Time = 26.01 to 29.70 Sec

◇ & 10 DEG TC #4
 □ & 10 DEG TC #3
 △ & 5 DEG TC #2
 ○ & 0 DEG TC #1

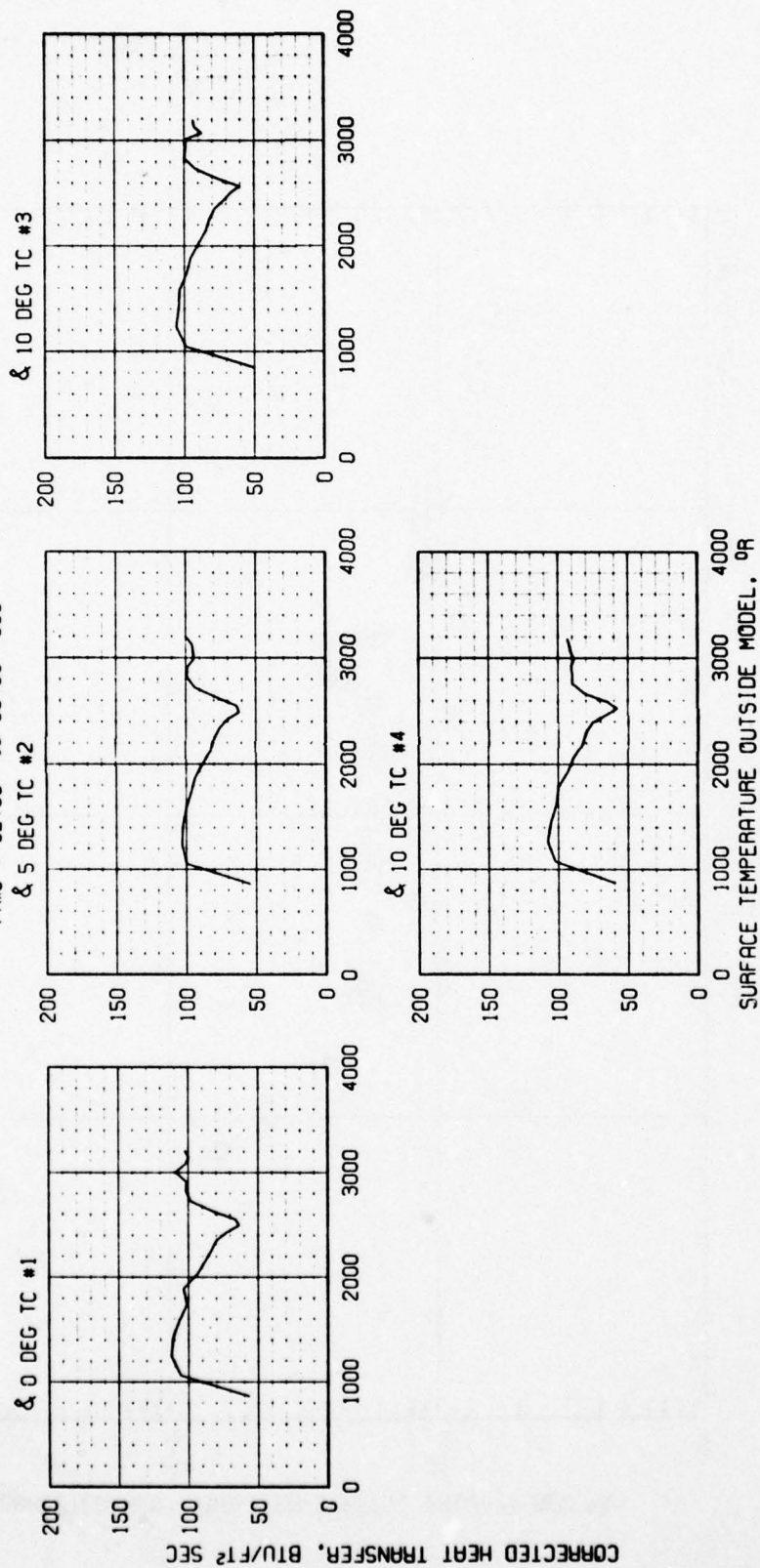


AD0021 RUN 7 MODEL T1-53 DUST + WATER
 MODEL HEMI P0 = 1002 T0 = 5900
 Time = 26.01 to 29.70 Sec

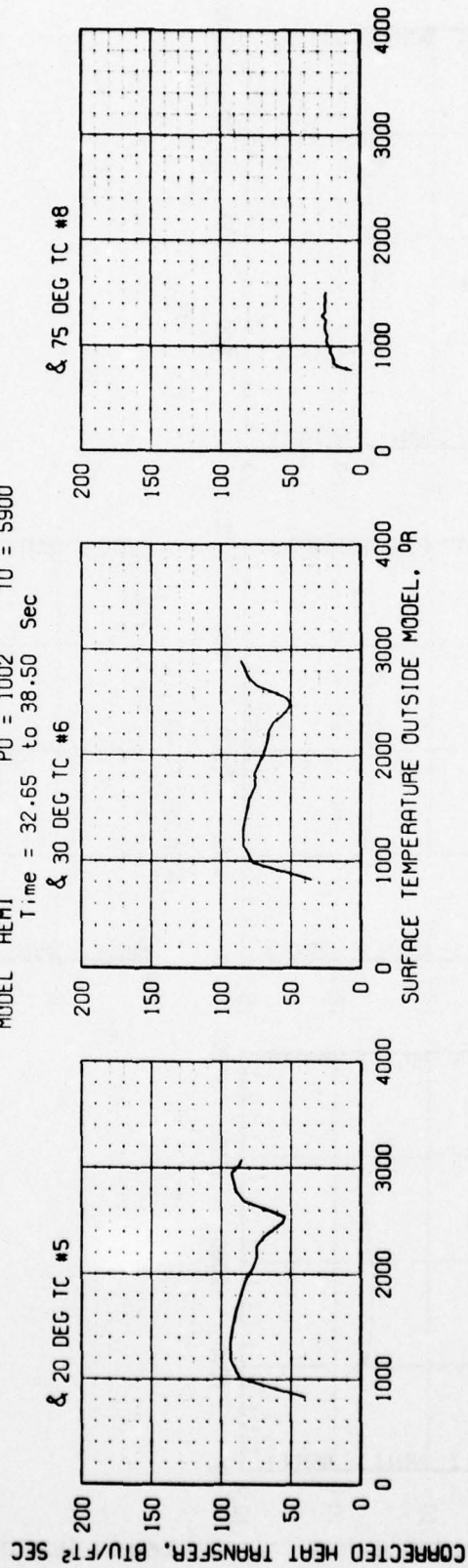
◇ 10 DEG TC #4
 □ 10 DEG TC #3
 △ 5 DEG TC #2
 ○ 0 DEG TC #1



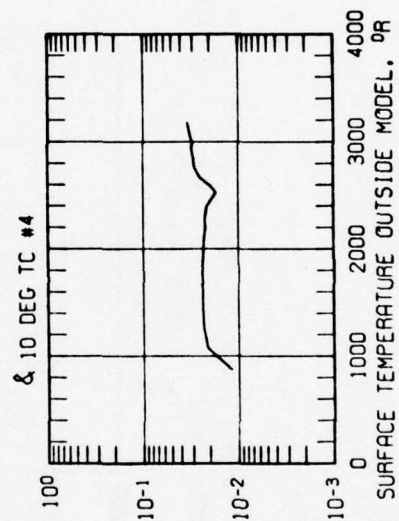
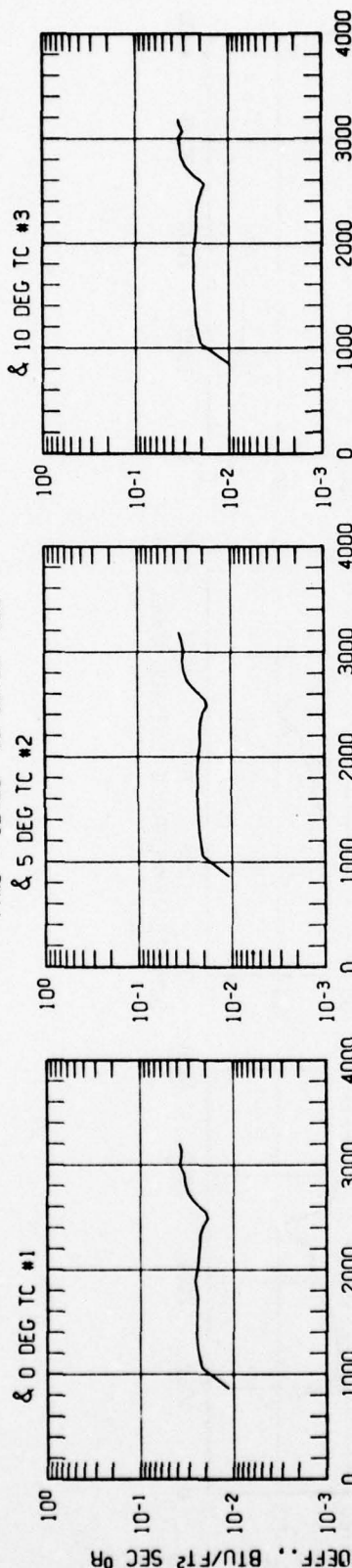
AD021 RUN 7 MODEL TI-23 WATER
 MODEL HEMI P0 = 1002 T0 = 5900
 Time = 32.65 to 38.50 Sec



AD021 RUN 7 MODEL T1-23 WATER
 MODEL HEMI PO = 1002 TO = 5900
 Time = 32.65 to 38.50 Sec



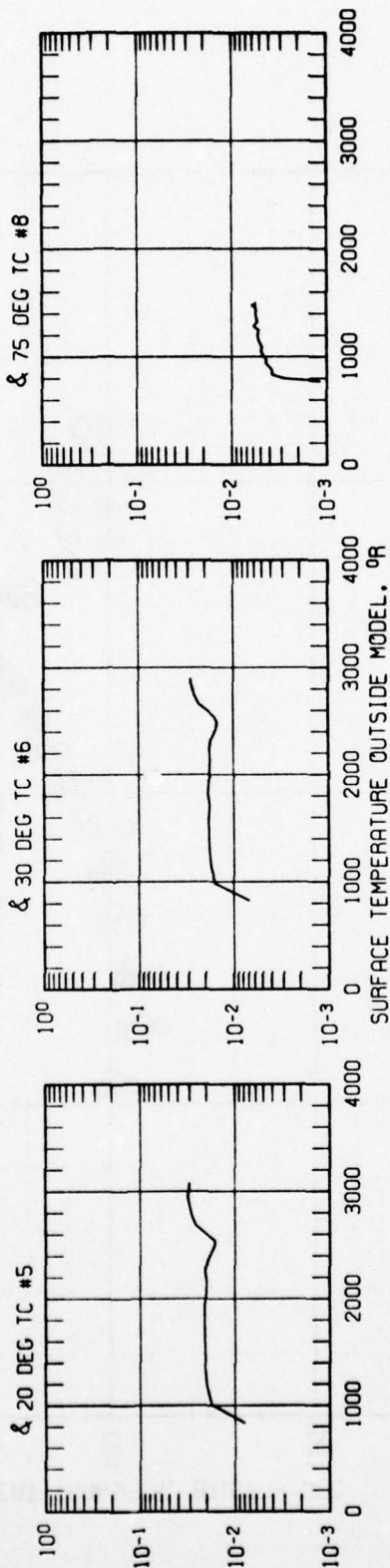
AD021 RUN 7 MODEL T1-23 WATER
 MODEL HEMI PO = 1002 TO = 5900
 Time = 32.65 to 38.50 Sec



CORRECTED HEAT TRANSFER COEFF., BTU/FT² SEC OR

SURFACE TEMPERATURE OUTSIDE MODEL, OR

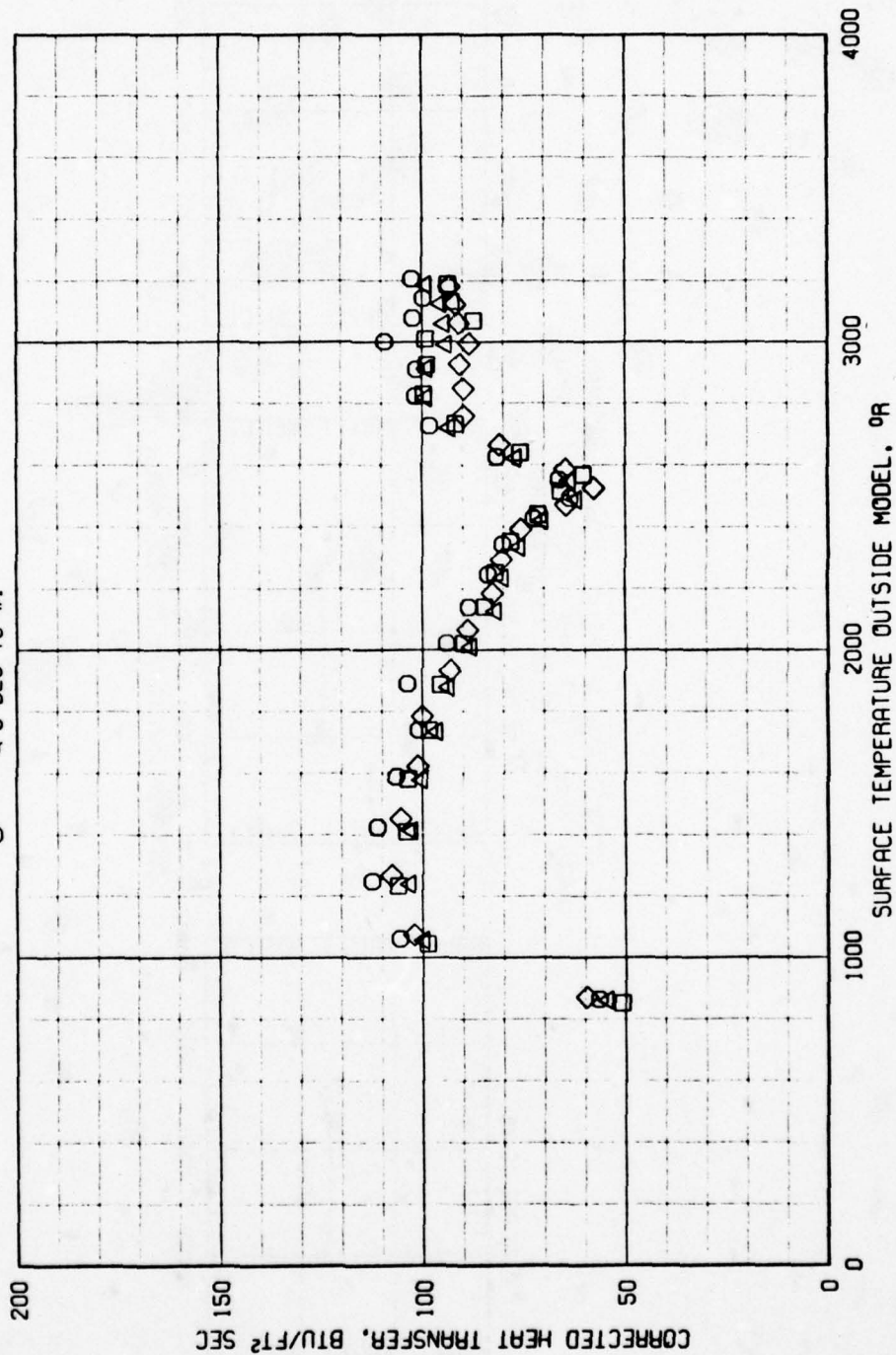
CORRECTED HEAT TRANSFER COEFF., BTU/FT² SEC °R



AD021 RUN 7 MODEL T1-23 WATER
 MODEL HEMI P0 = 1002 T0 = 5900
 Time = 32.65 to 38.50 Sec

AD021 RUN 7 MODEL TI-23 WATER
 MODEL HEMI P0 = 1002 T0 = 5900
 Time = 32.65 to 38.50 Sec

◇ 10 DEG TC #4
 □ 10 DEG TC #3
 △ 5 DEG TC #2
 ○ 0 DEG TC #1



AD021 RUN 7 MODEL T1-23 WATER
 MODEL HEMI P0 = 1002 T0 = 5900
 Time = 32.65 to 38.50 Sec

◇ & 10 DEG TC #4
 □ & 10 DEG TC #3
 △ & 5 DEG TC #2
 ○ & 0 DEG TC #1

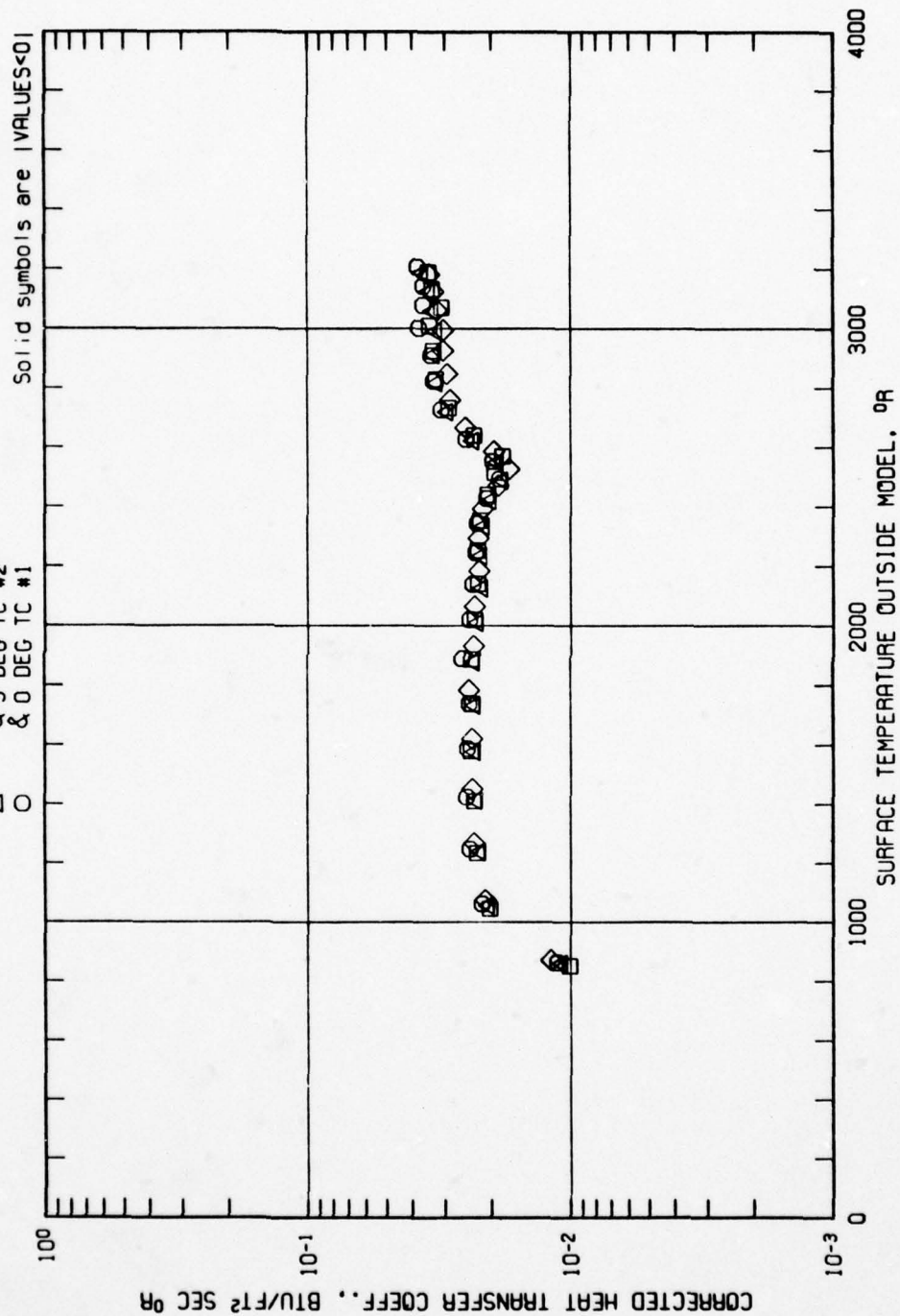


TABLE 1 RUN SUMMARY

RUN 8 DATE 1-21-77

TUNNEL CONDITIONS

$P_0 = 1004$ psia, $P_{0m} = 1016$ psia
 $H_{0g} = 1865$ Btu/lbm, $H_{0m} = 1804$ Btu/lbm
 $H_0 = 1865$ Btu/lbm
 $T_{0g} = 6020$ °R, $T_0 = 9.9$ °R
 $M = 6.6$ $P_0' = 9.9$ psia

NOZZLE STATION 127.5

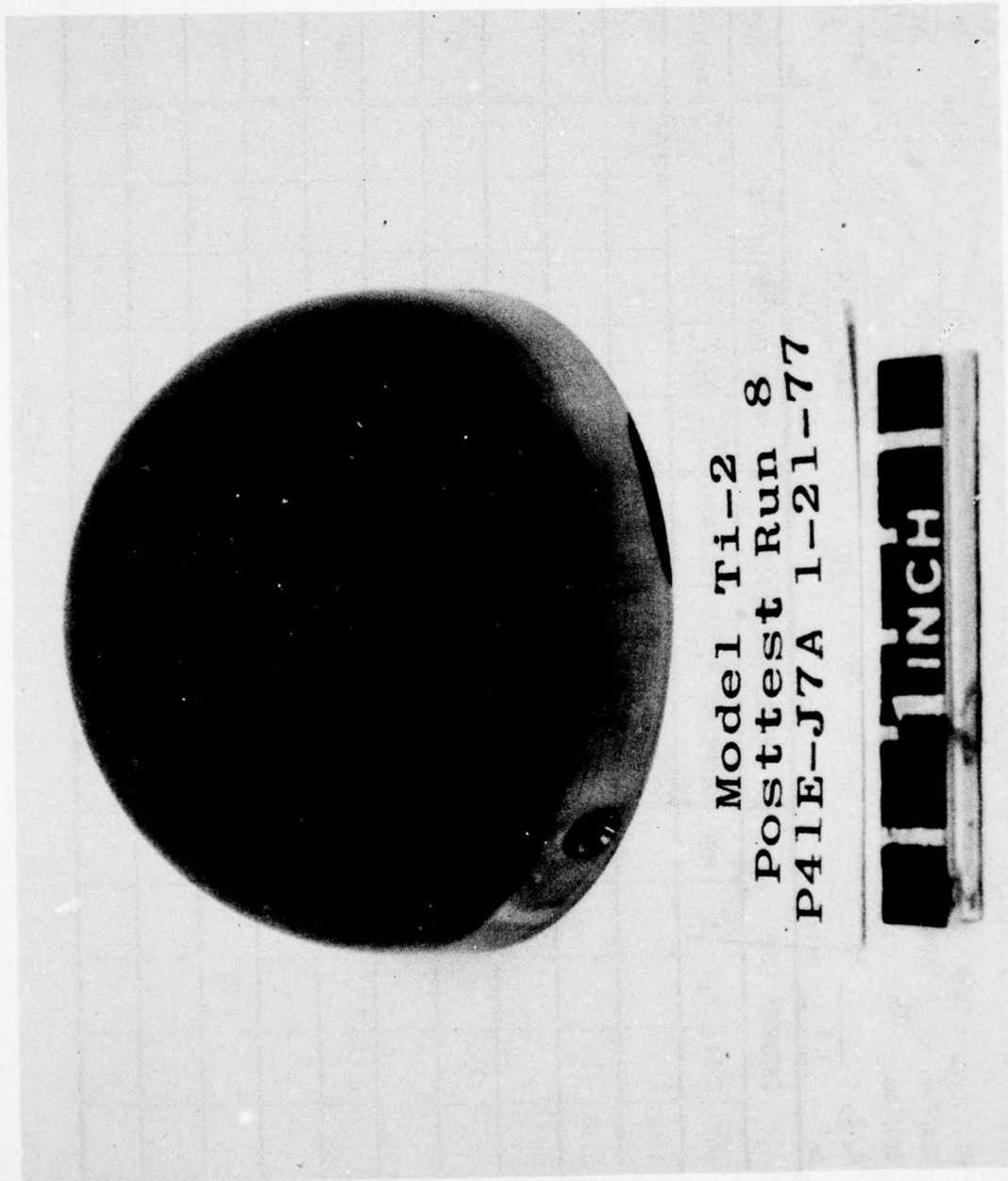
TYPE Mq0 Flow 0.287 gpm
 SIZE 100 µm C.F. 19.0
 VEL 5560 ft/sec Orifice 0.020 in.
 Flow 7.26 gm/sec ΔP 214 psi
 C.F. 17.6

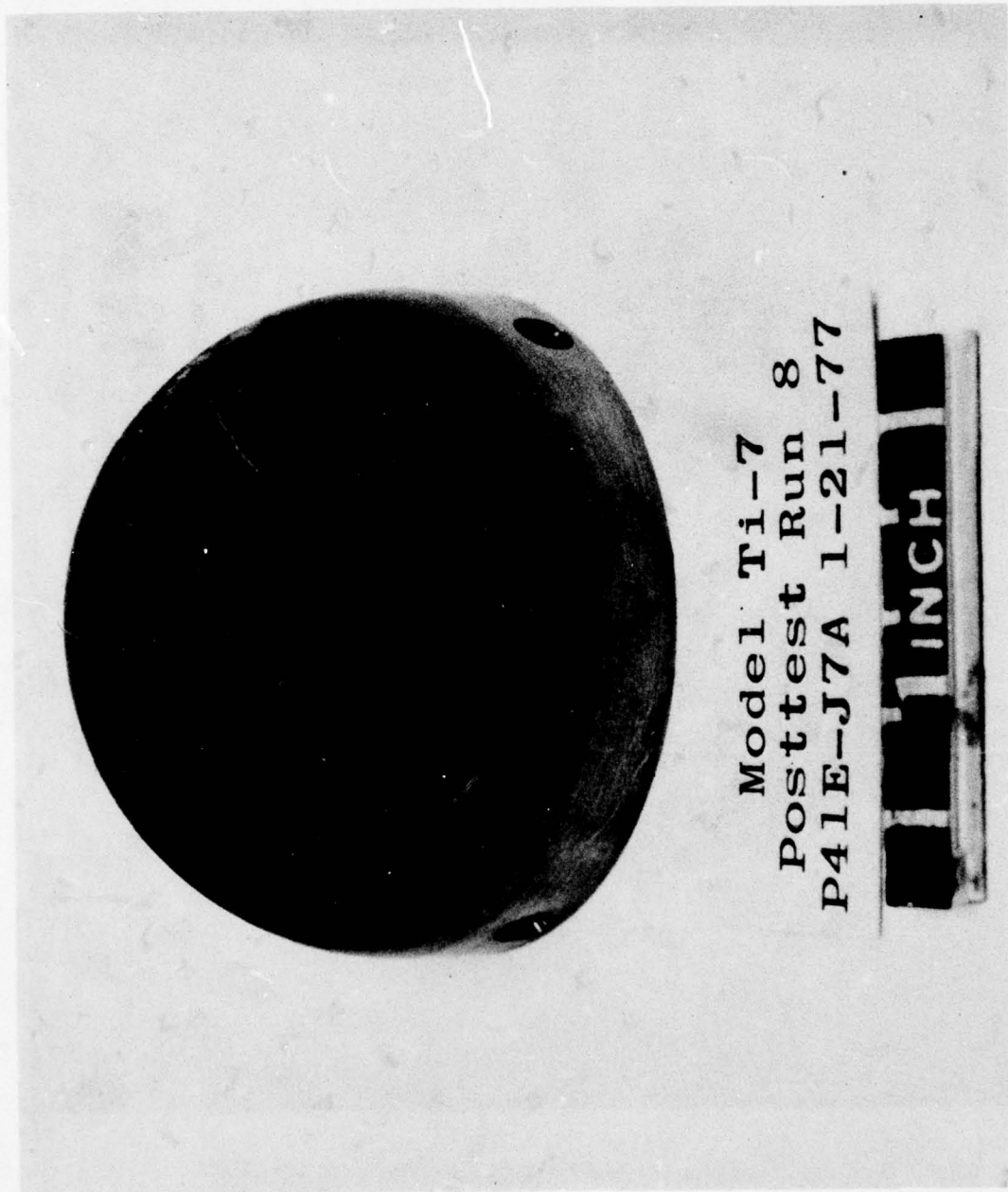
S I N G	MODEL NUMBER	EXPOSURE TIME				MODEL DESCRIPTION			MODEL INSTRUMENTATION					PHOTOGRAPHS		
		PH	DUST	H ₂ O	DUST & H ₂ O	POH	GEOMETRY	DIAM, In.	MATERIAL	T/C TYPE	NO. OF T/C's	PR. TAP	NO. OF TAPS	TRANS- DUCER TYPE	PRERUN	POSTRUN
1	P ₀ probe	3.04					See Fig. 3	1.0	SS			x	1	Strain Gage		
2	T _i -2	3.32					Hemi	2.0	6A-4V- T _i	S	8				237	600
3	Empty															
4	T _i -18		1.94				Hemi	2.0	6A-4V- T _i	S	8				95	603
5	Empty															
6	T _i -7		2.17	2.17	x		Hemi	2.0	6A-4V- T _i	S	8				101	601
7	Empty															
8	T _i -17			2.03		1.11	Hemi	2.0	6A-4V- T _i	S	8				92	602
9																
10																

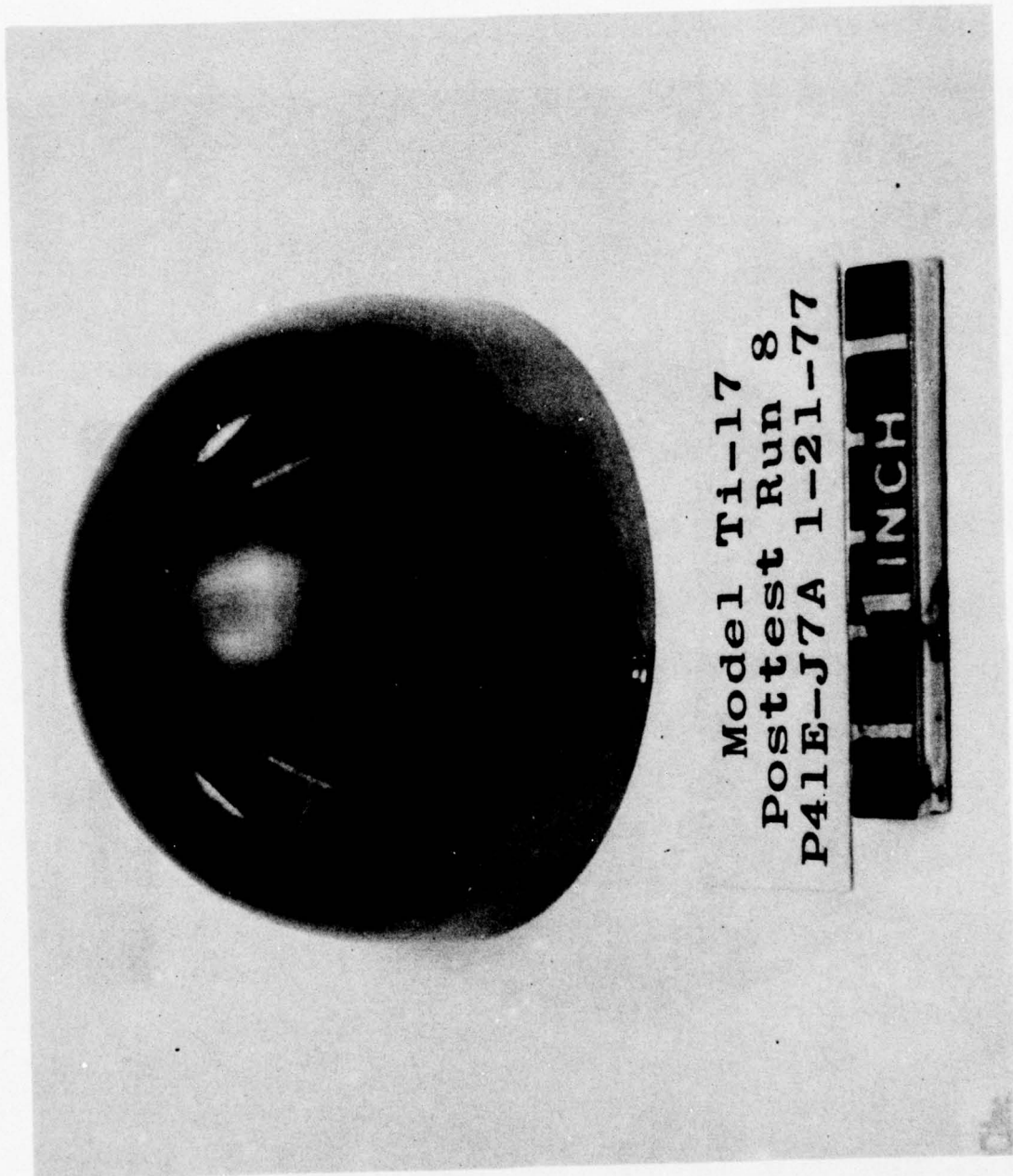
KEY -

PH - PREHEAT
 POH - POSTHEAT
 DUST AND H₂O - IF CHECKED, MEANS DUST AND WATER FLOWING AT SAME TIME

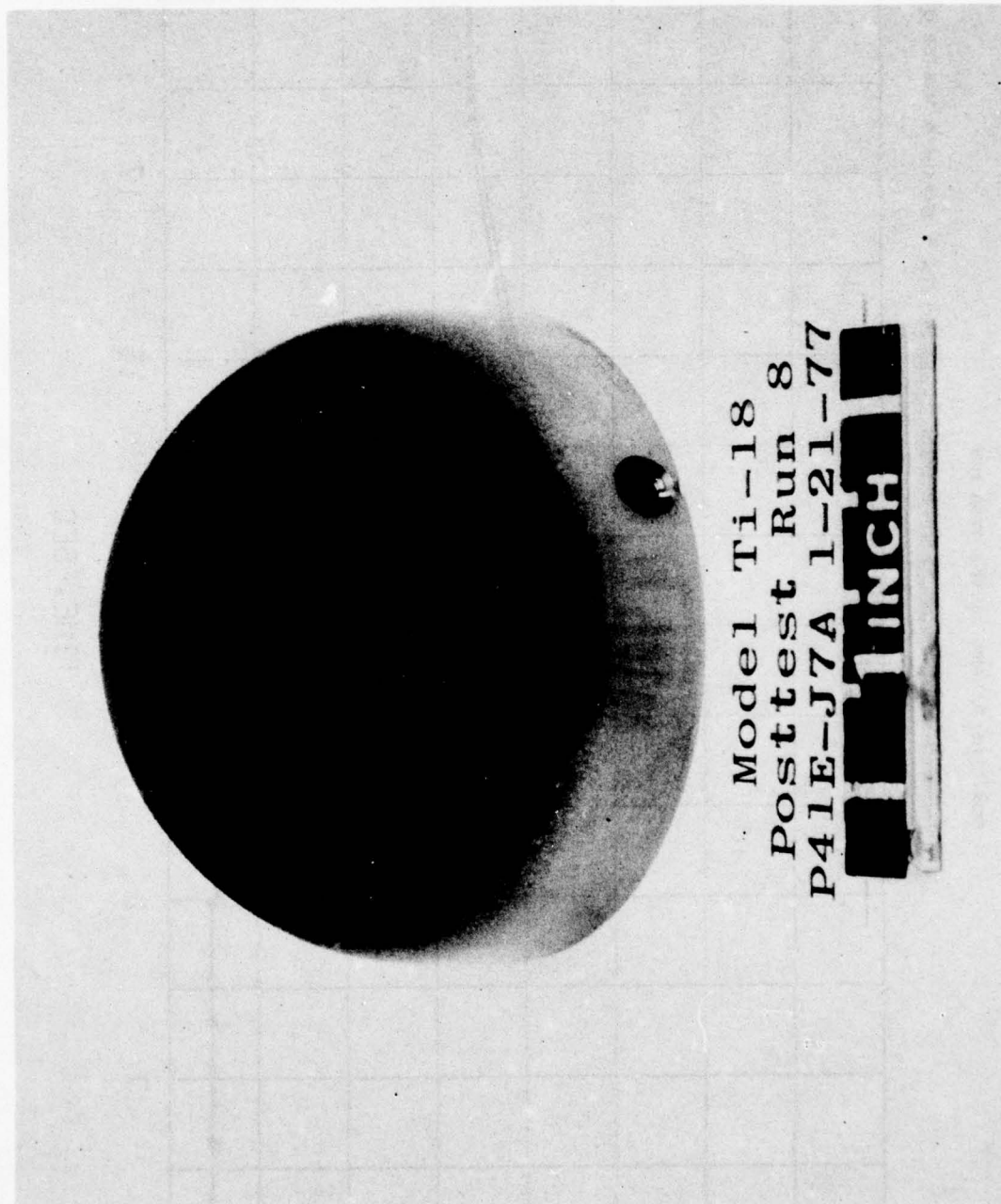
NOTES:







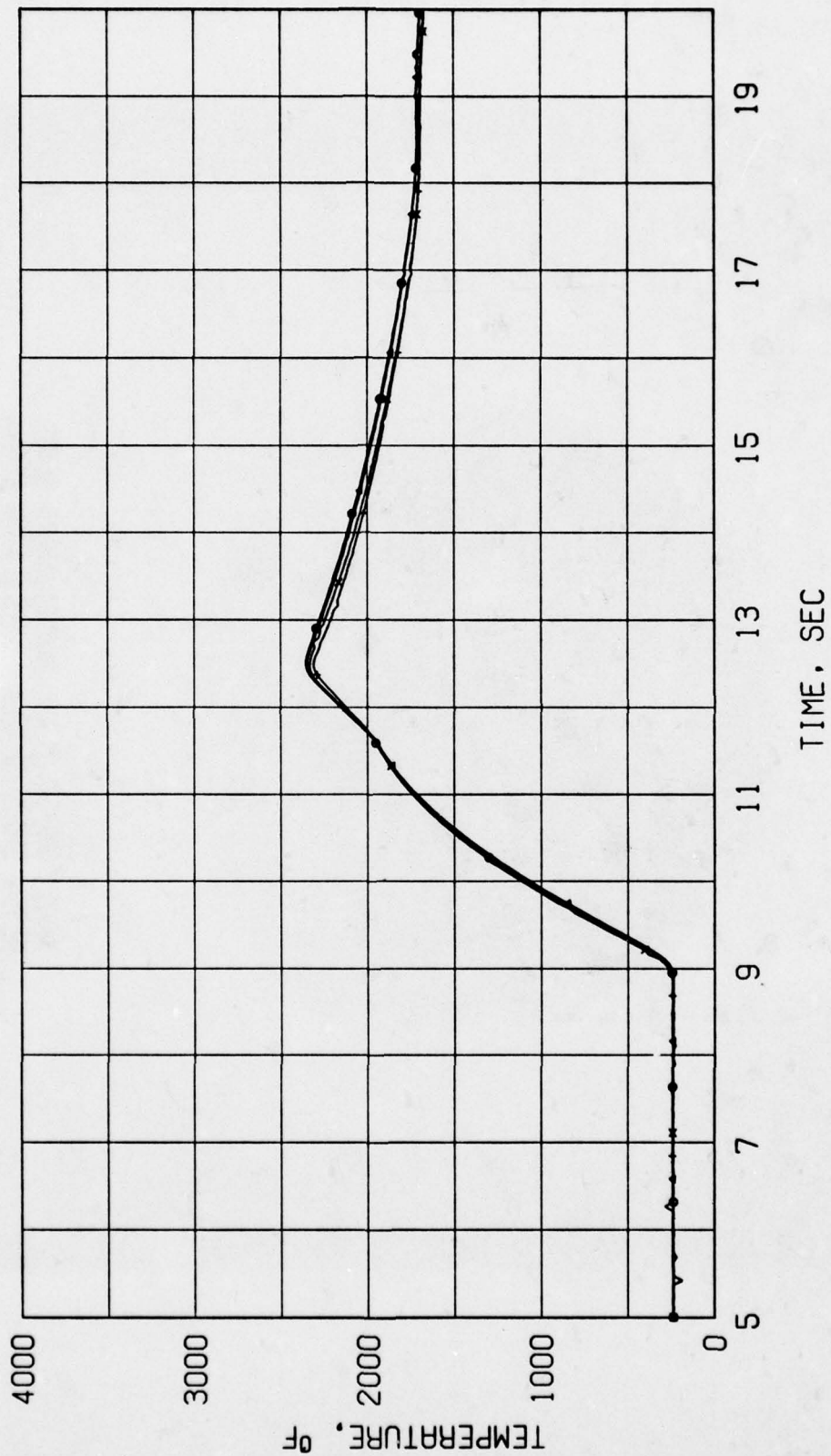
Model Ti-17
Posttest Run 8
P41E-J7A 1-21-77



DATE 01-24-77 PRO INC
PROJ-P41E

PROJECT P41E TEST #0021 DATE 01-21-77 SEL 2108

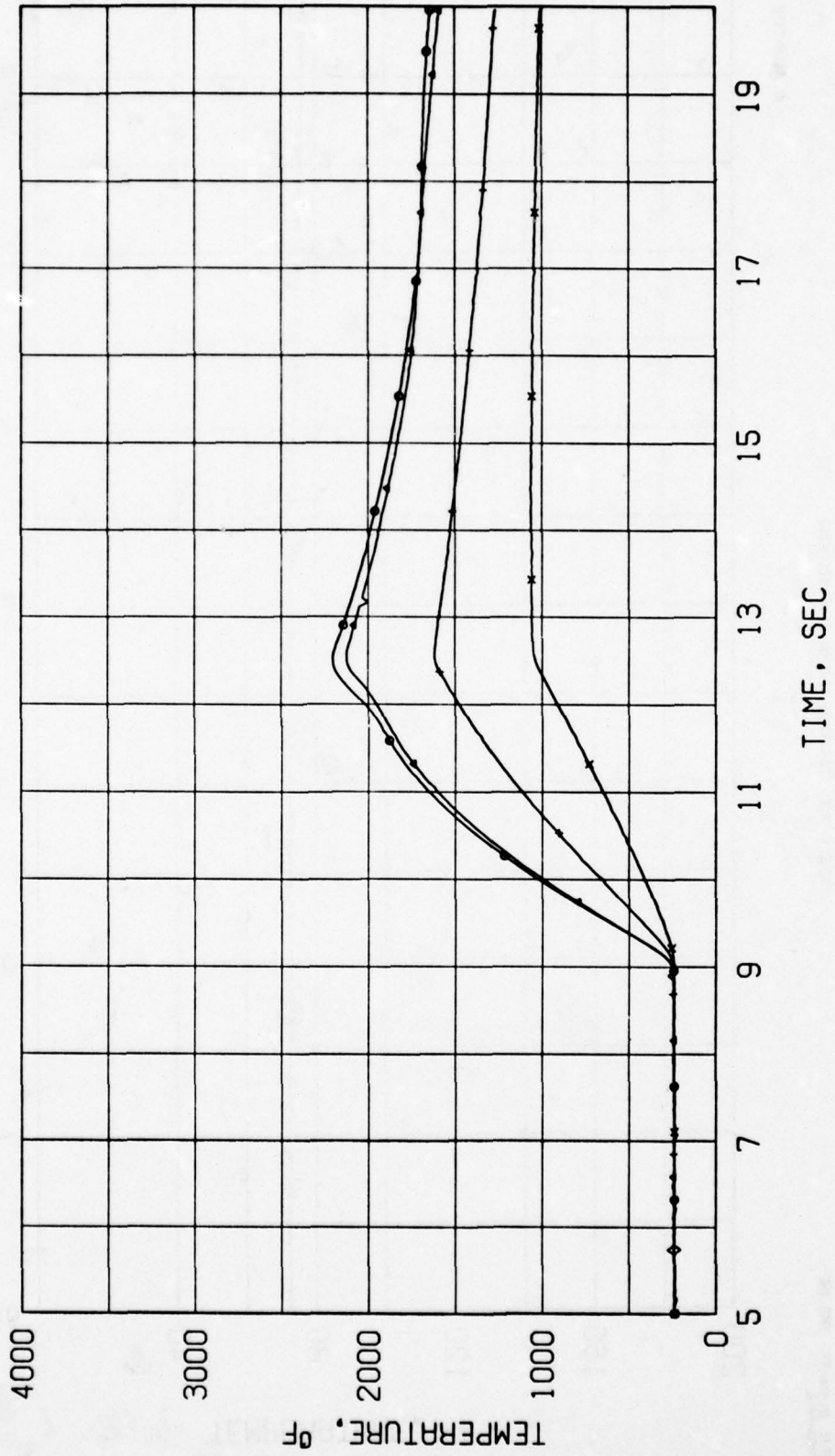
X TC-4-T1-2 + TC-3-T1-2 ▲ TC-2-T1-2 ○ TC-1-T1-2



DATE 01-24-77 RND INC
PROJ-P41E

PROJECT P41E TEST R0021 DATE 01-21-77 SEL 2108

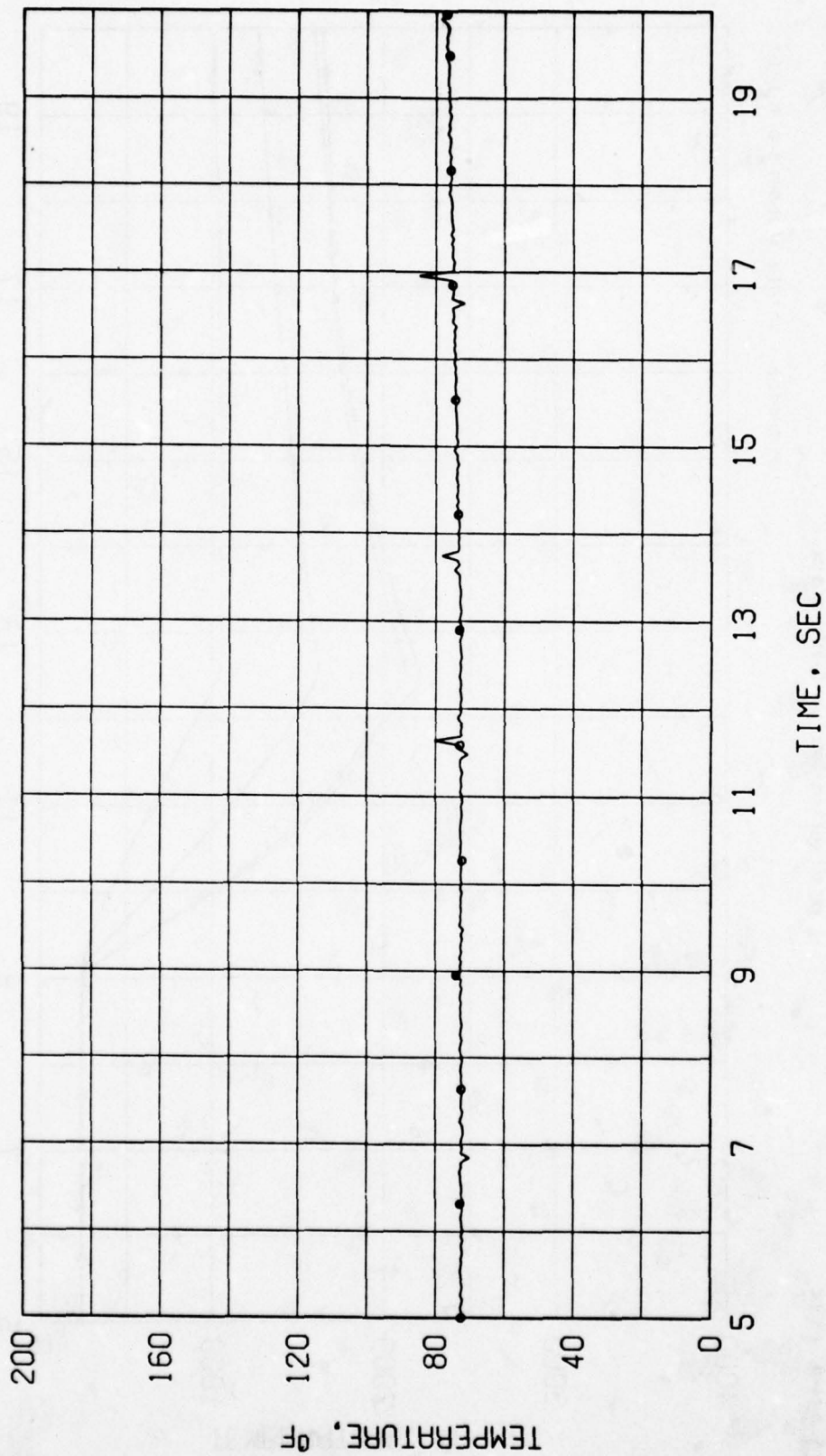
X TC-8-TI-2 + TC-7-TI-2 ▲ TC-6-TI-2 ○ TC-5-TI-2



DATE 01-24-77 RRO INC
PROJ-P41E

PROJECT P41E TEST R0021 DATE 01-21-77 SEL 2108

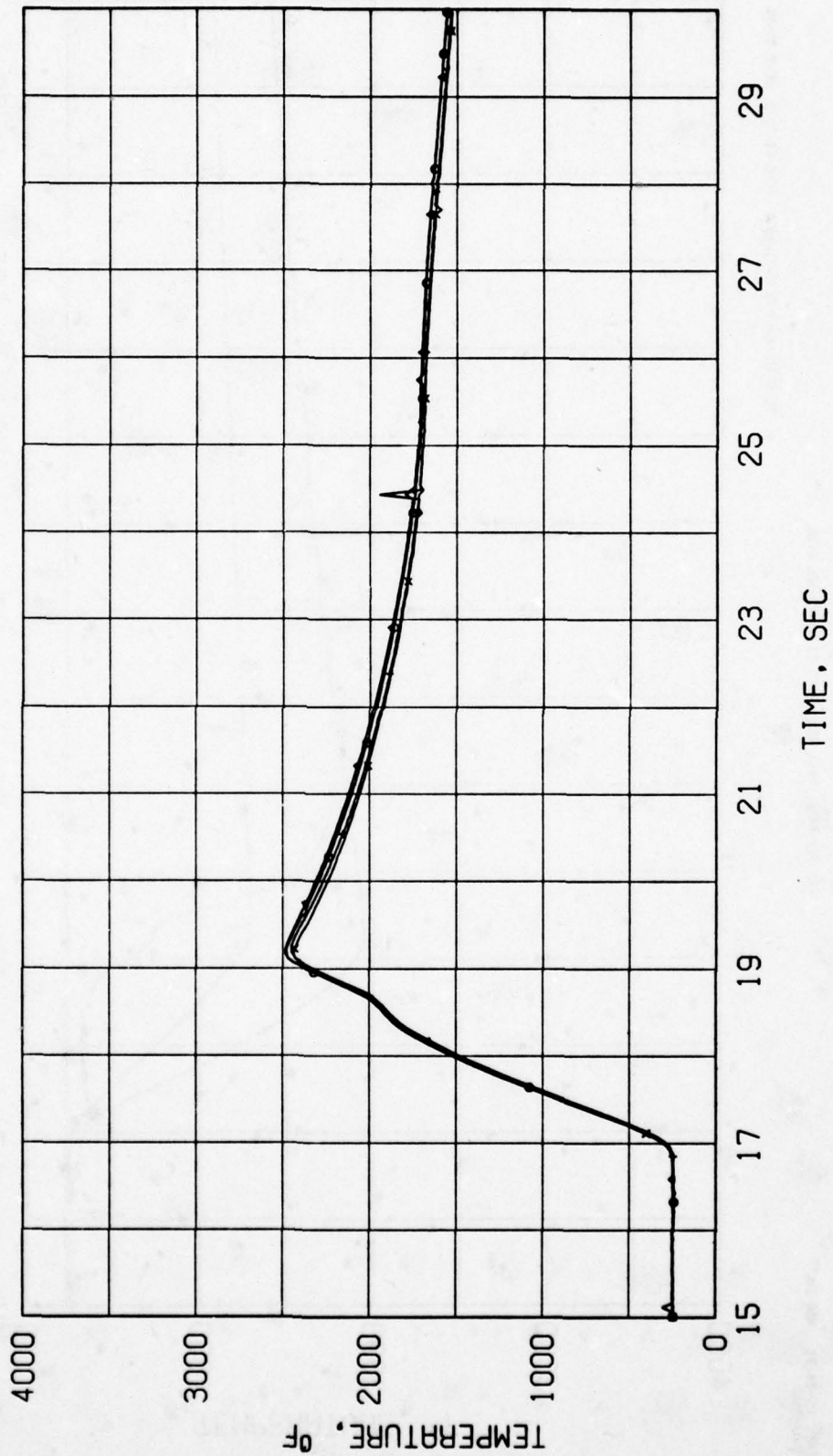
© TC-9-71-2



DATE 01-24-77 RND INC
PROJ-P41E

PROJECT P41E TEST R0021 DATE 01-21-77 SEL 2108

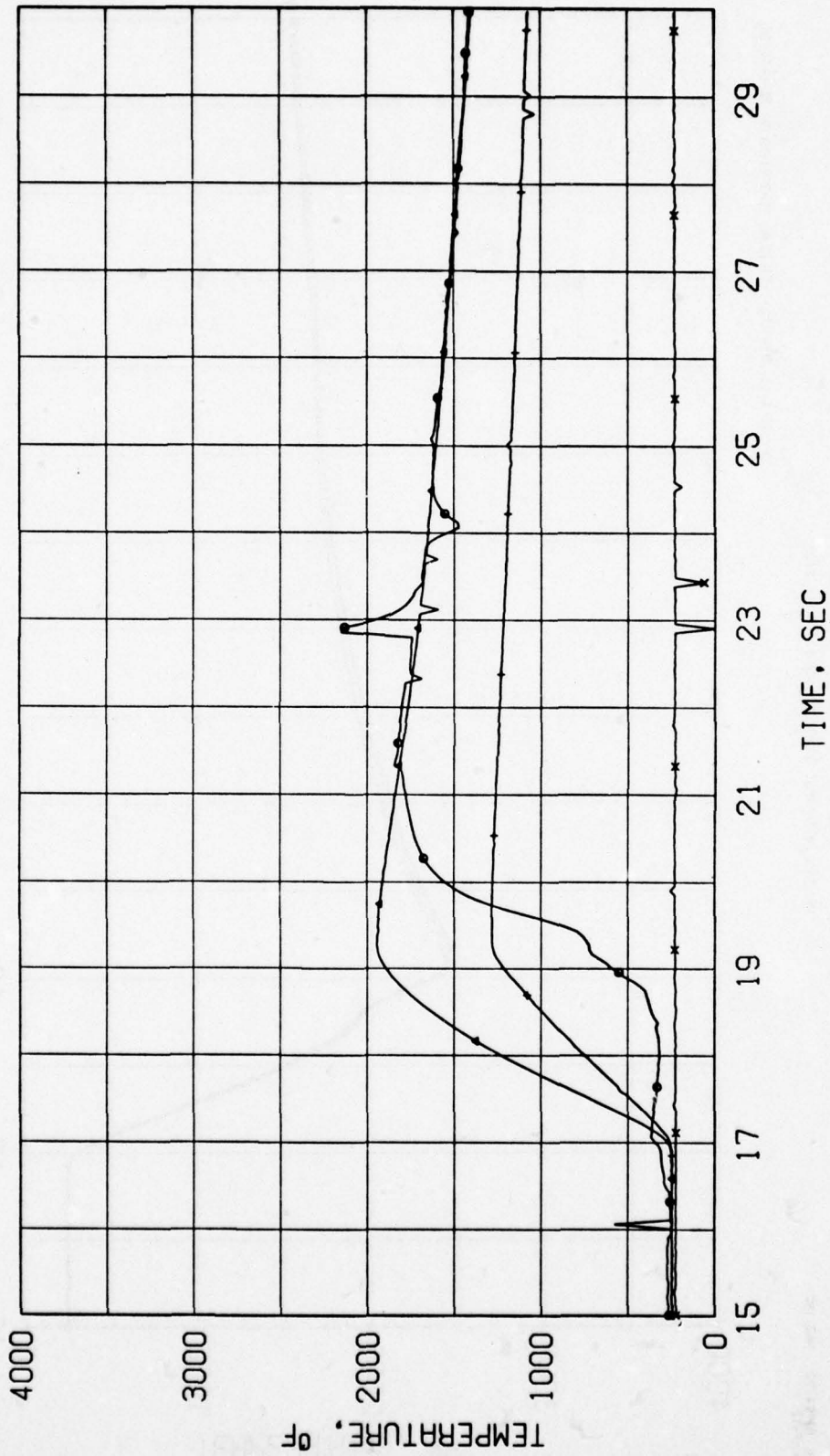
X TC-4-TI-18 + TC-3-TI-18 ▲ TC-2-TI-18 ○ TC-1-TI-18



DATE 01-24-77 RRD INC
PROJ-P41E

PROJECT P41E TEST R0021 DATE 01-21-77 SEL 2108

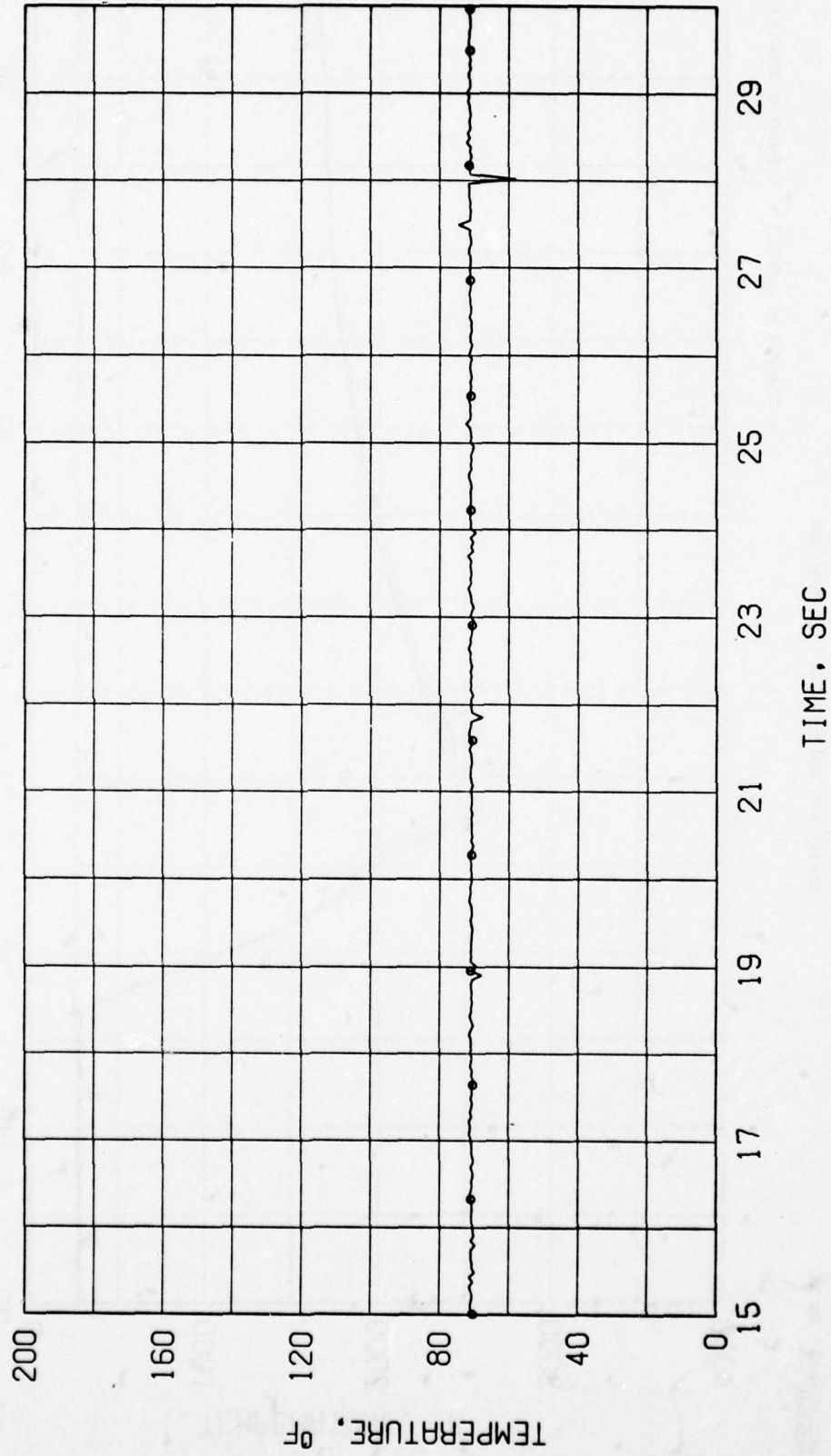
X TC-8-TI-18 + TC-7-TI-18 Δ TC-6-TI-18 ○ TC-5-TI-18



DATE 01-24-77 RND INC
PROJ-P4IE

PROJECT P4IE TEST R0021 DATE 01-21-77 SEL 2108

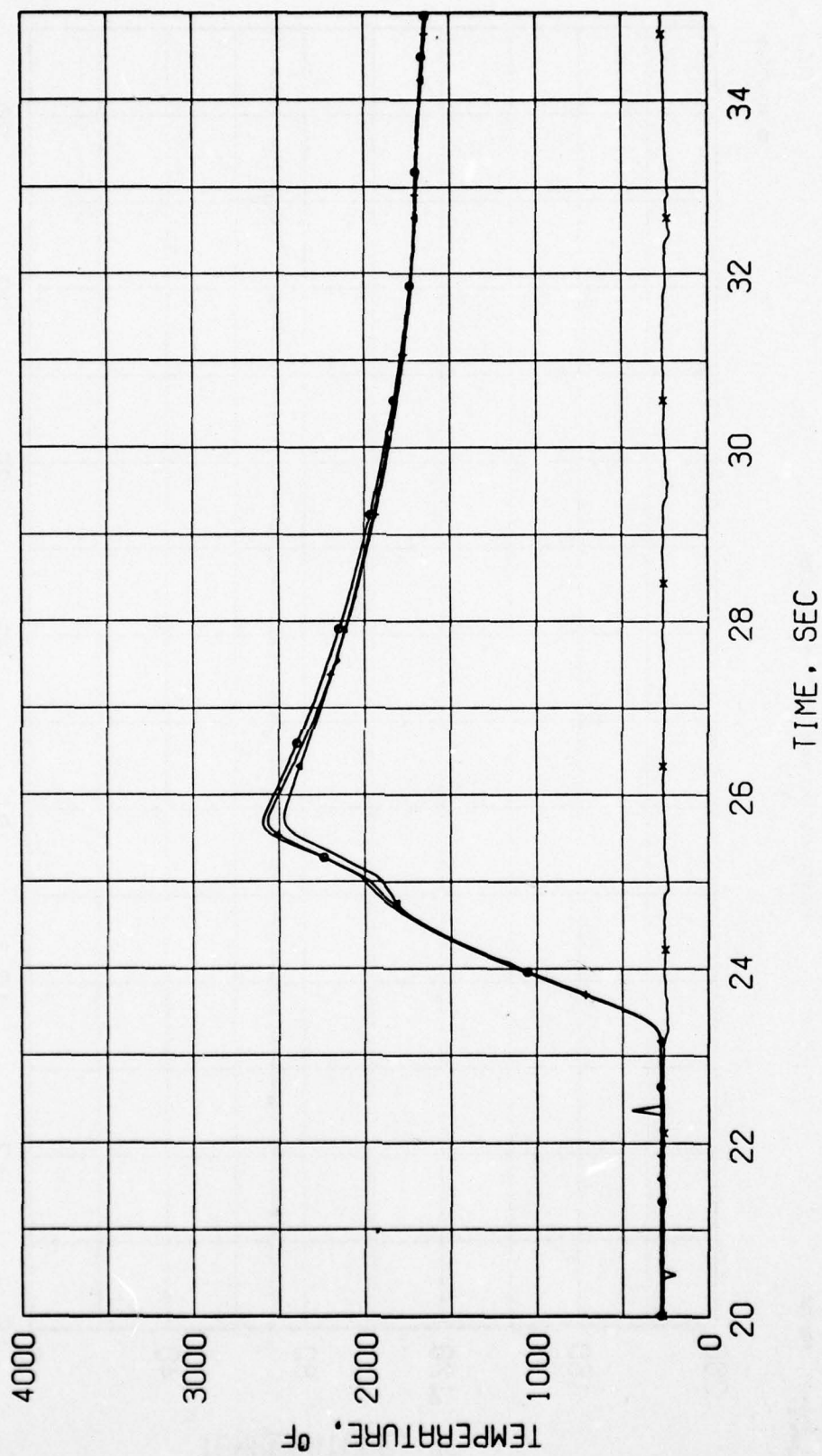
TC-9-11-18



DATE 01-24-77 RRO INC
PROJ-P41E

PROJECT P41E TEST R0021 DATE 01-21-77 SEL 2108

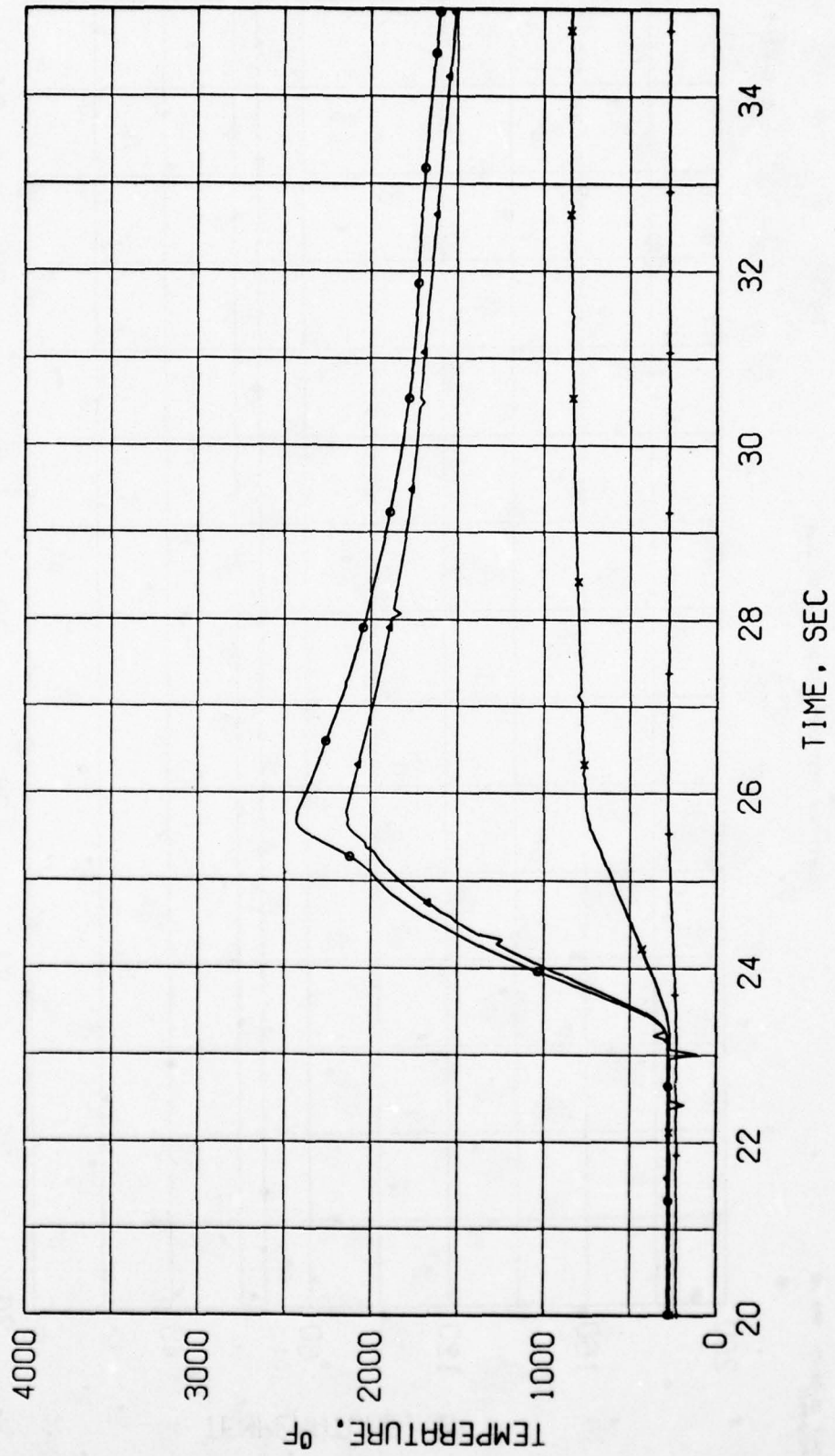
X TC-4-T1-7 + TC-3-T1-7 ▲ TC-2-T1-7 ○ TC-1-T1-7



DATE 01-24-77 PRO INC
PROU-P41E

PROJECT P41E TEST R0021 DATE 01-21-77 SEL 2108

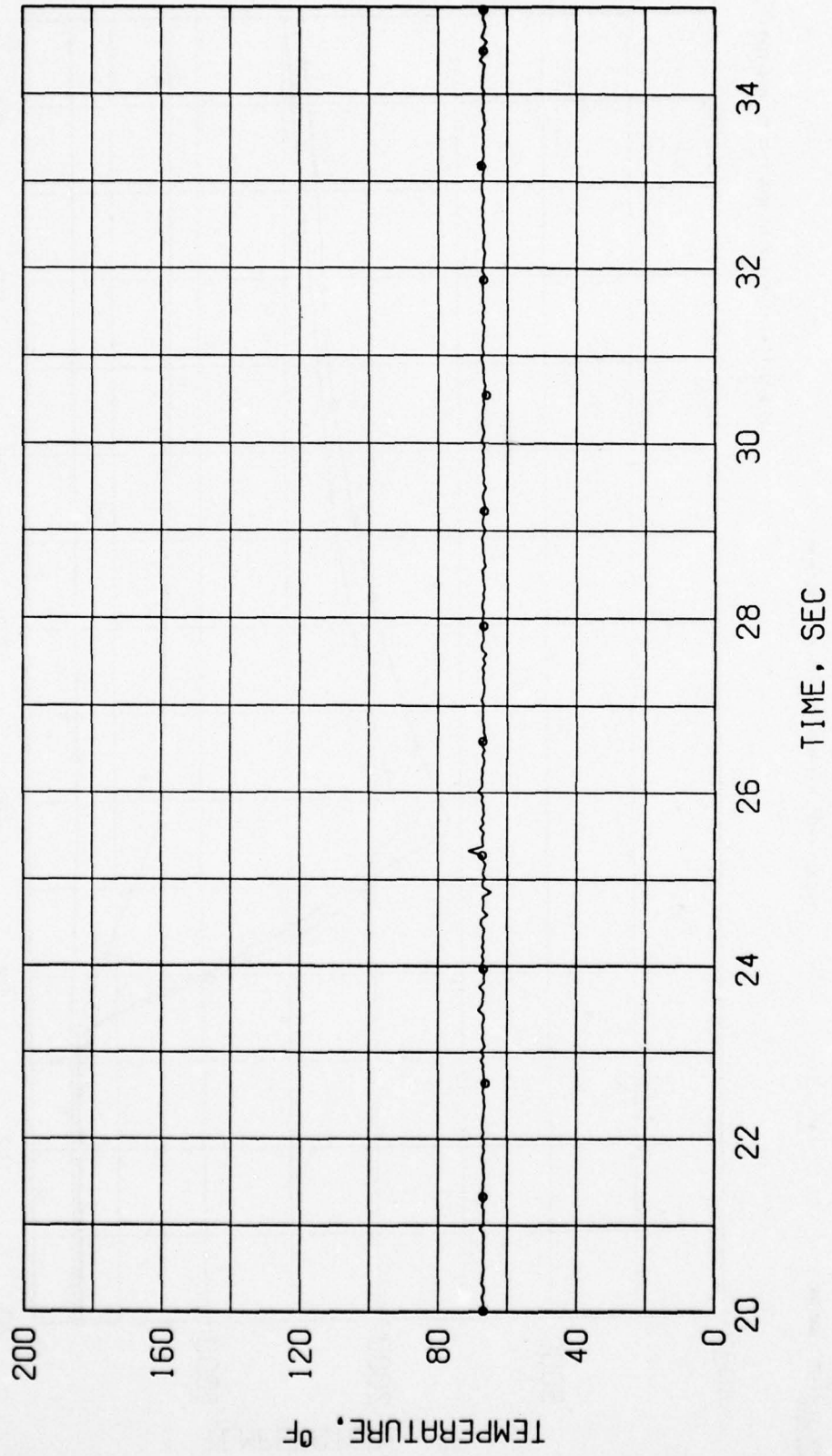
X TC-8-T1-7 + TC-7-T1-7 ▲ TC-6-T1-7 ○ TC-5-T1-7



DATE 01-24-77 RRD INC
PROJ-P41E

PROJECT P41E TEST R0021 DATE 01-21-77 SEL 2108

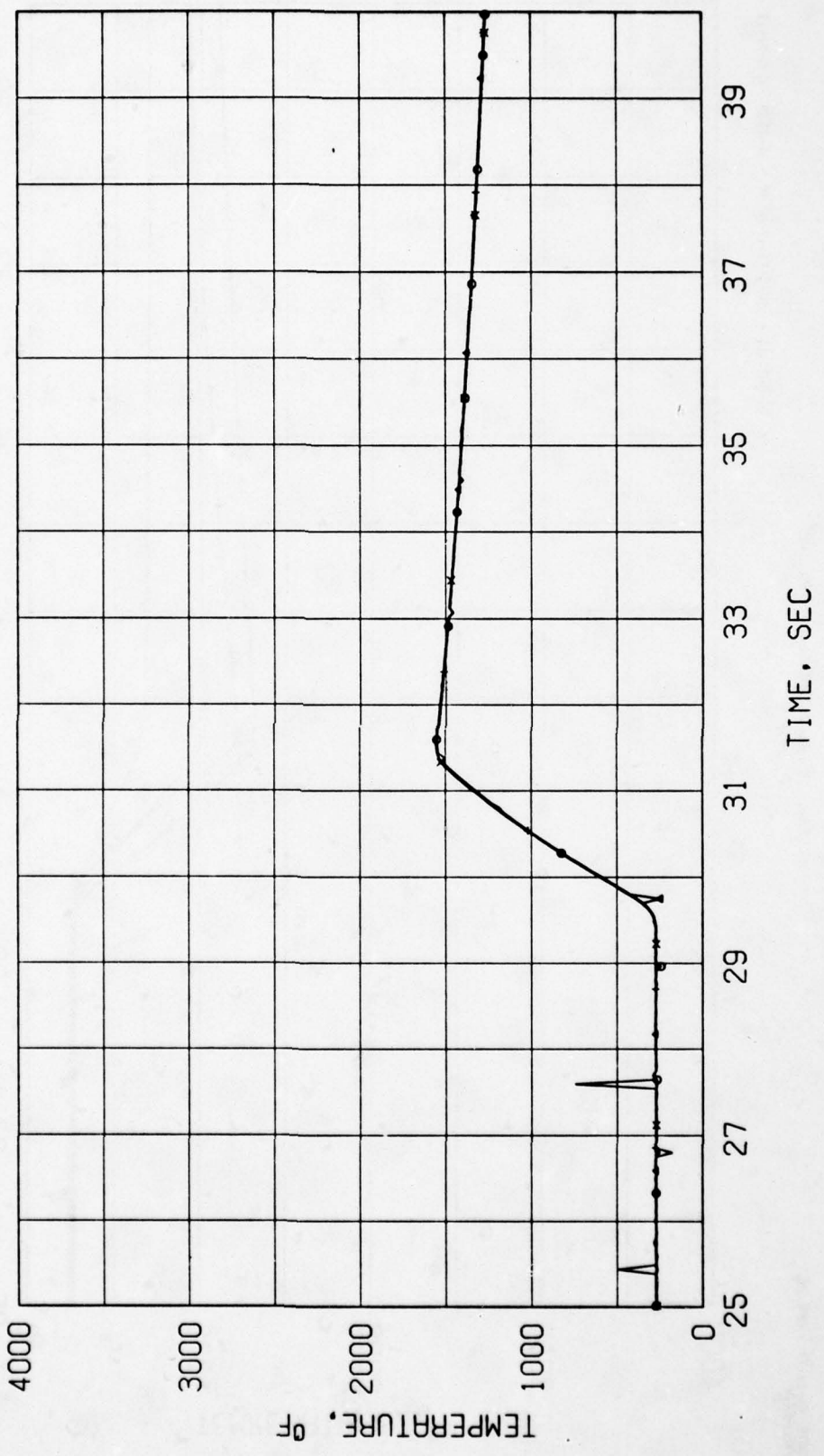
0 TC-9-11-7



DATE 01-24-77 RRG INC
PROJ-P41E

PROJECT P41E TEST R0021 DATE 01-21-77 SEL 2108

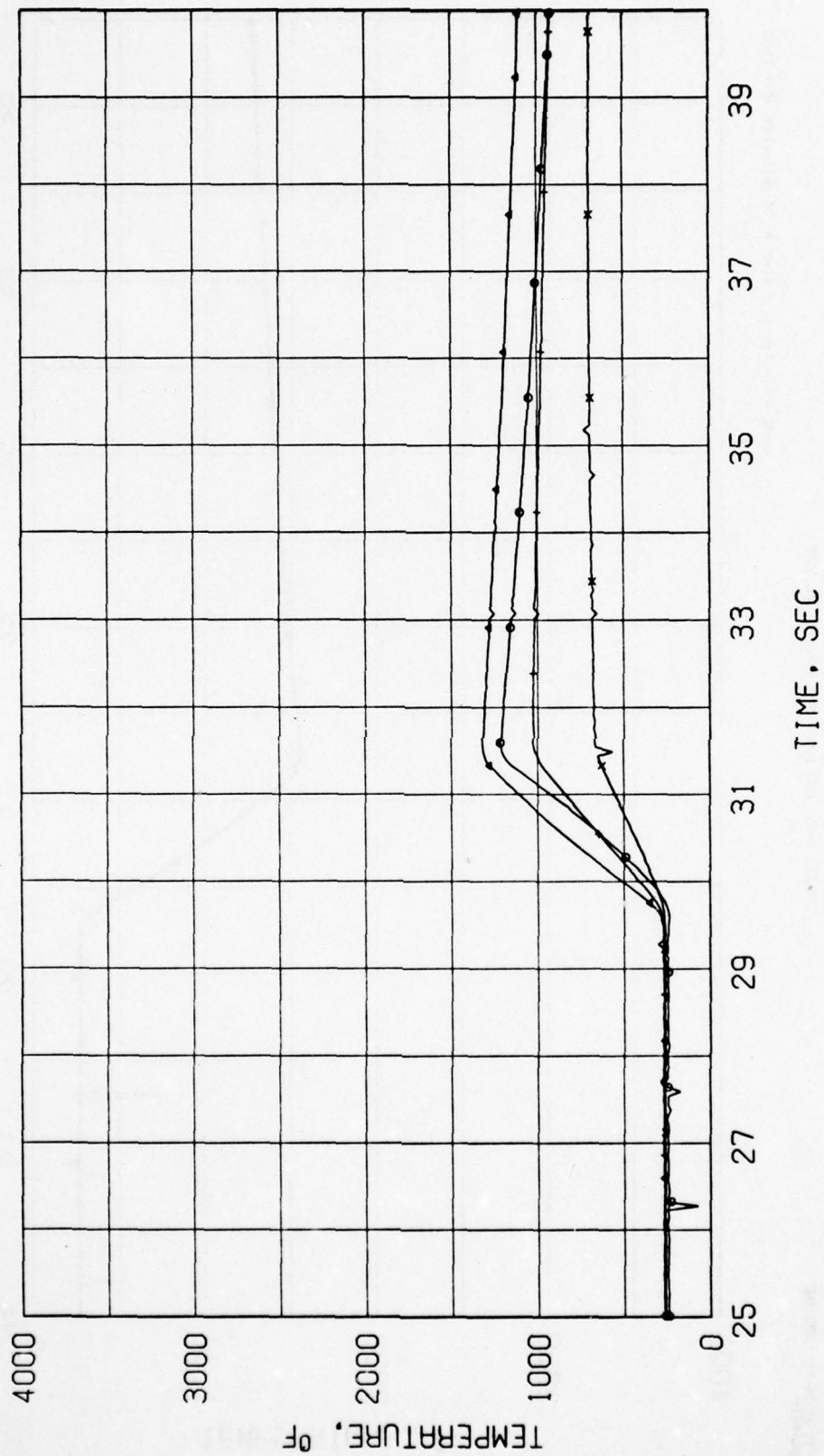
X TC-4-T1-17 + TC-3-T1-17 Δ TC-2-T1-17 ○ TC-1-T1-17



DATE 01-24-77 RRO INC
PROJ-P41E

PROJECT P41E TEST R0021 ORTE 01-21-77 SEL 2108

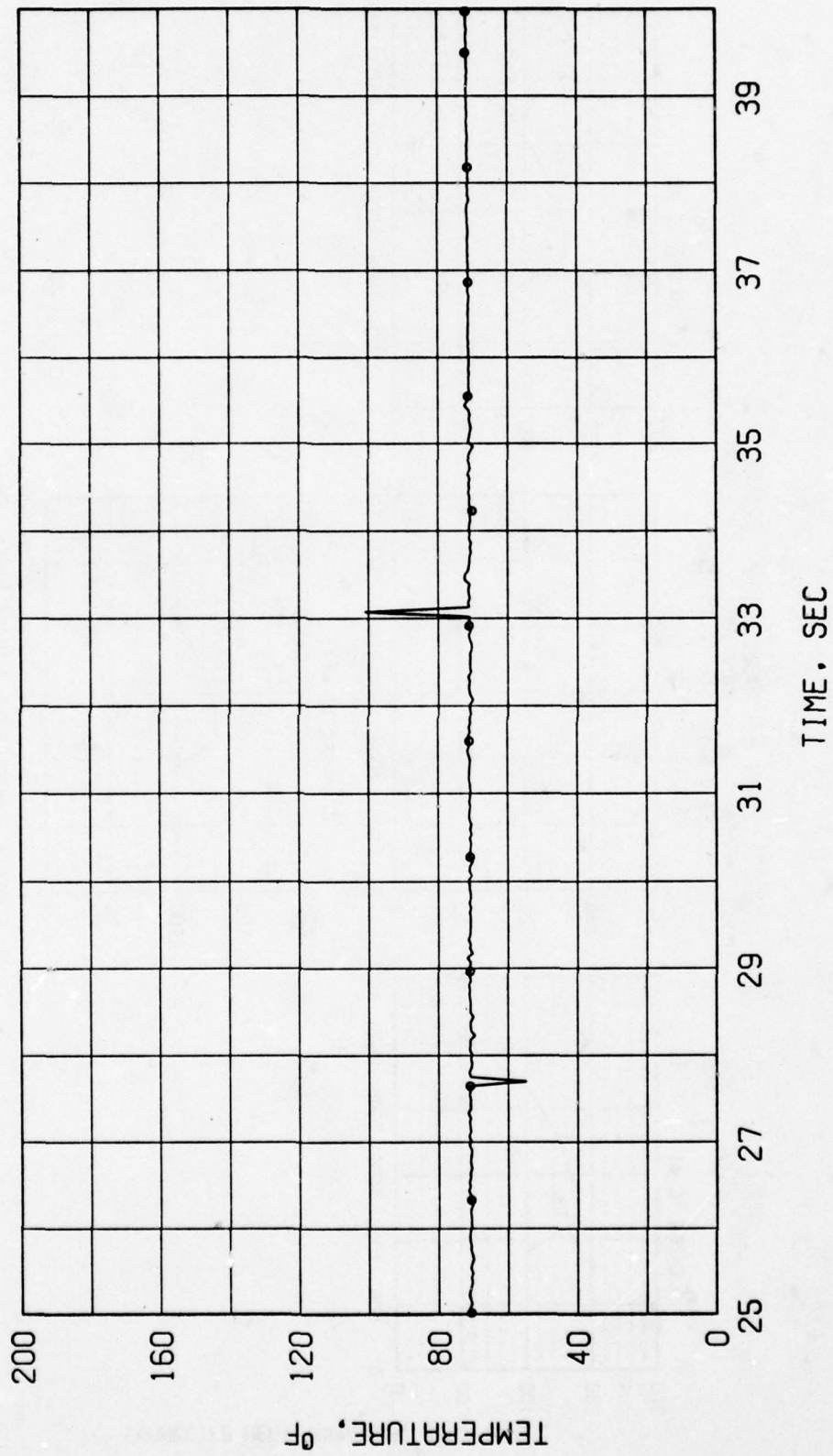
X TC-8-TI-17 + TC-7-TI-17 ▲ TC-6-TI-17 ○ TC-5-TI-17



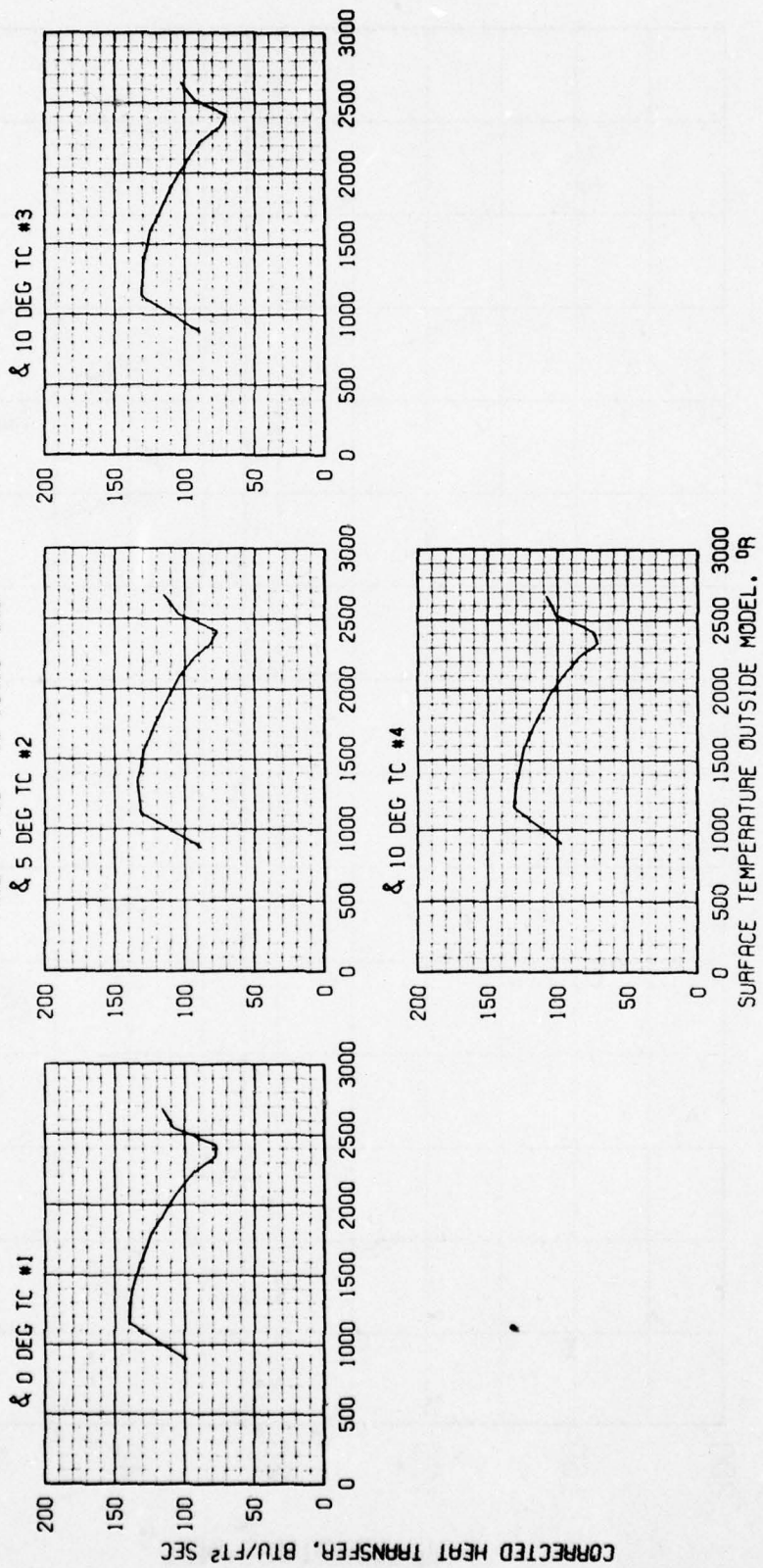
DATE 01-24-77 RRO INC
PROJ-P41E

PROJECT P41E TEST R0021 DATE 01-21-77 SEL 2108

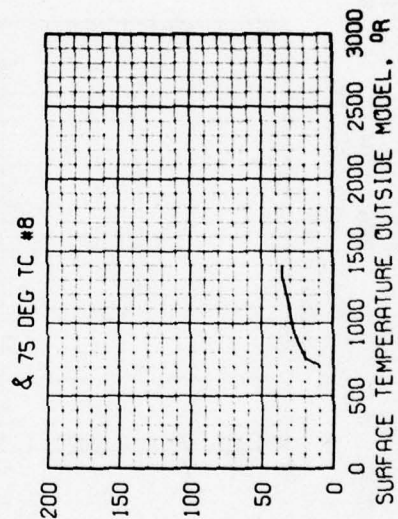
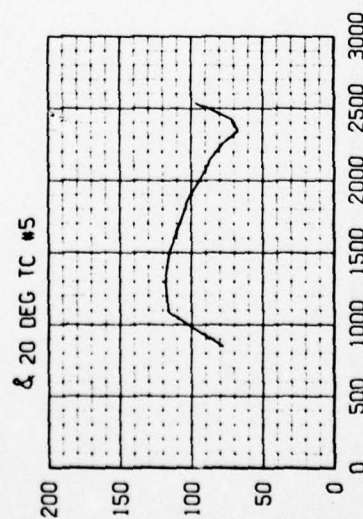
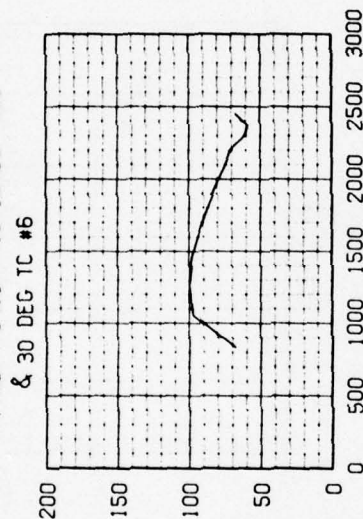
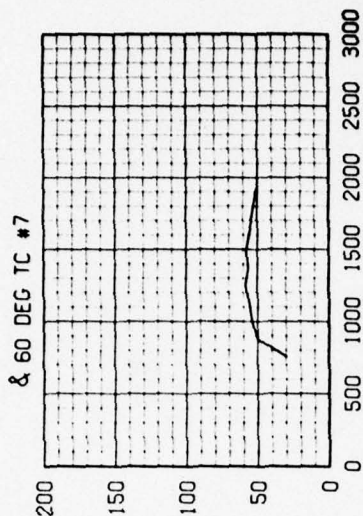
0 TC-9-TI-17



AD021 RUN 8 MODEL T1-2 CLEAR
 MODEL HEMI P0 = 1004 T0 = 6020
 Time = 9.16 to 12.50 Sec



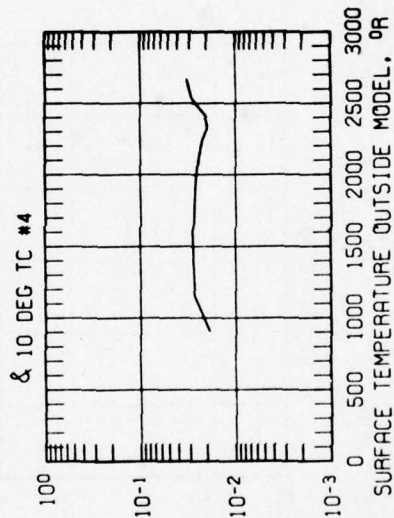
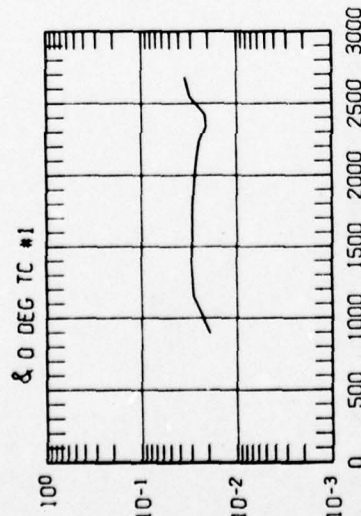
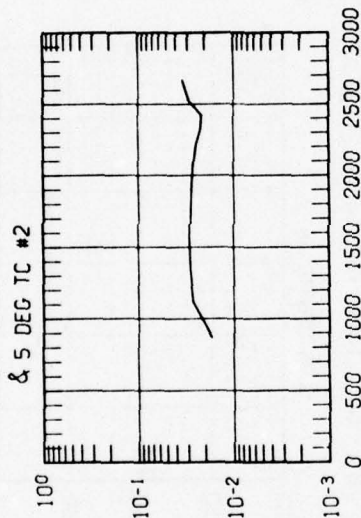
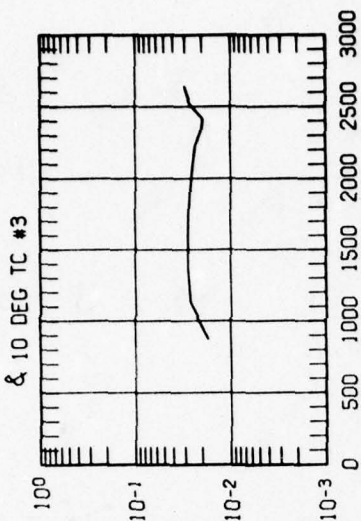
AD021 RUN 8 MODEL TI-2 CLEAR
 MODEL HEMI P0 = 1004 T0 = 6020
 Time = 9.16 to 12.50 Sec



CORRECTED HEAT TRANSFER, BTU/FT² SEC

0 500 1000 1500 2000 2500 3000
 SURFACE TEMPERATURE OUTSIDE MODEL, OR

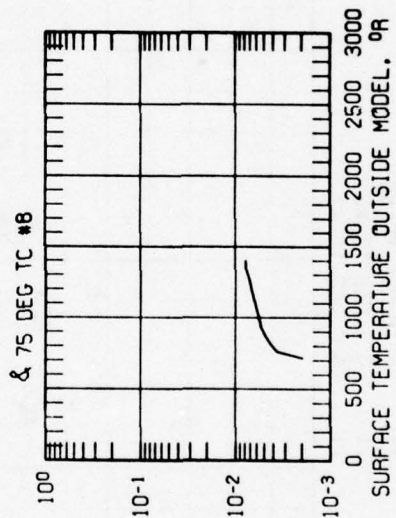
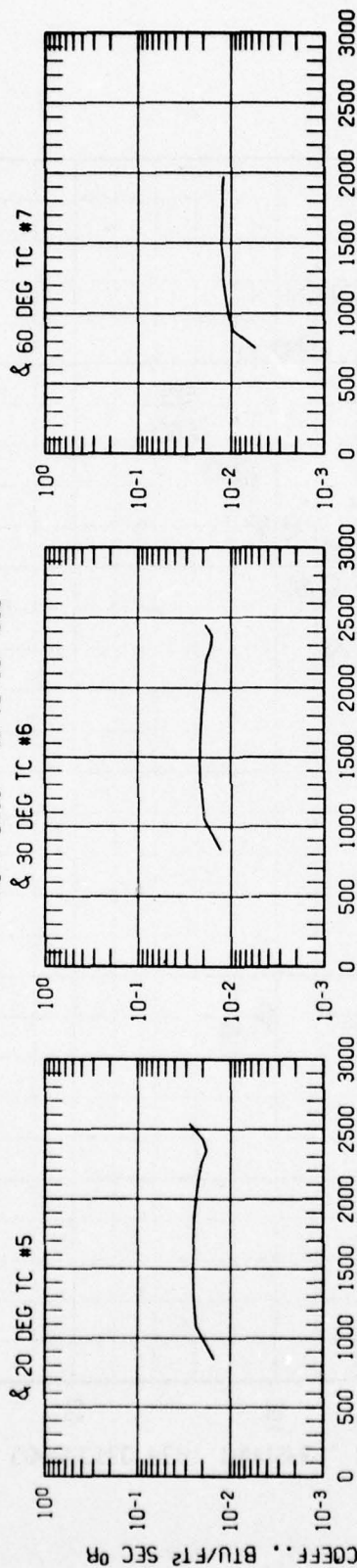
AD021 RUN 8 MODEL TI-2 CLEAR
 MODEL HEMI PO = 1004 TO = 6020
 Time = 9.16 to 12.50 Sec



CORRECTED HEAT TRANSFER COEFF., BTU/FT² SEC

SURFACE TEMPERATURE OUTSIDE MODEL, DEG

AD021 RUN 8 MODEL T1-2 CLEAR
 MODEL HEMI PO = 1004 TO = 6020
 Time = 9.16 to 12.50 Sec

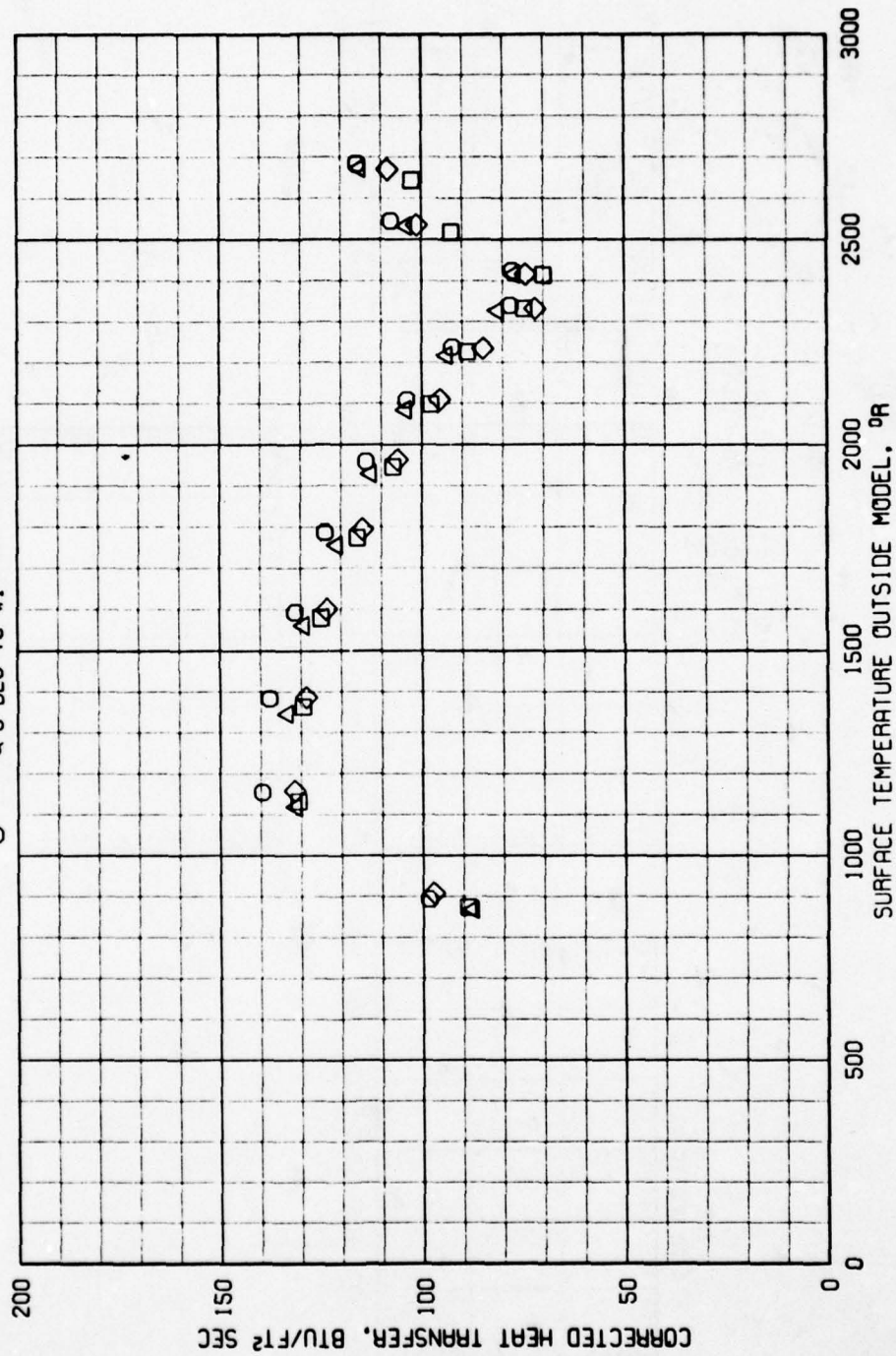


CORRECTED HEAT TRANSFER COEFF., BTU/FT² SEC °R

SURFACE TEMPERATURE OUTSIDE MODEL, °R

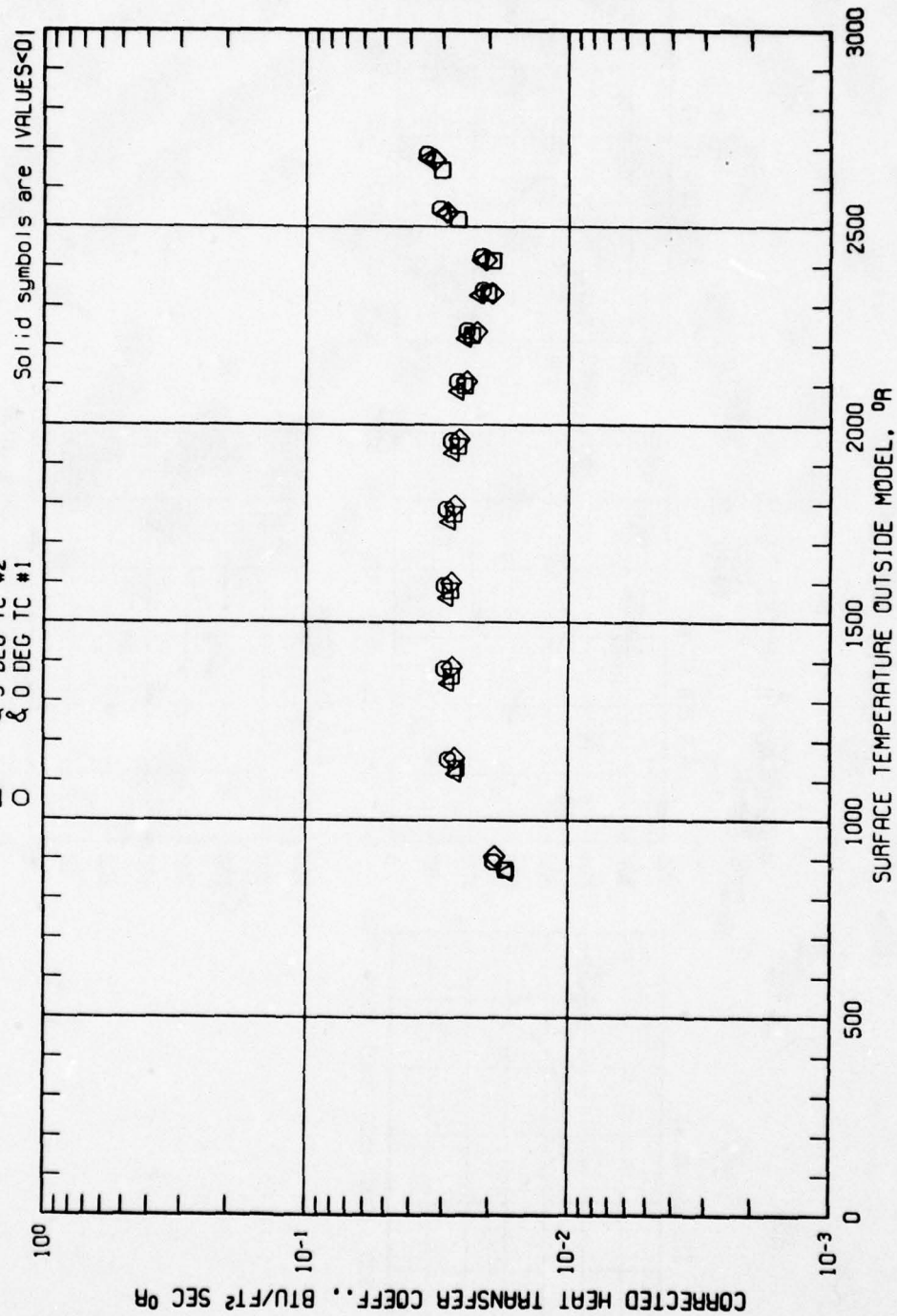
AD021 RUN 8 MODEL T1-2 CLEAR
 MODEL HEMI PO = 1004 TO = 6020
 Time = 9.16 to 12.50 Sec

◇ 10 DEG TC #4
 □ 10 DEG TC #3
 △ 5 DEG TC #2
 ○ 0 DEG TC #1

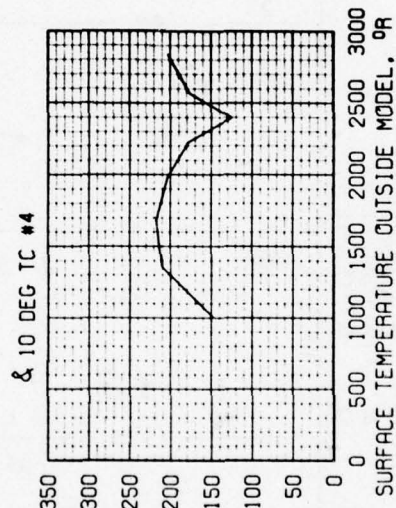
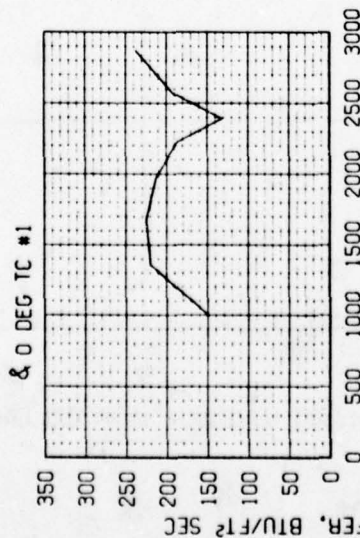
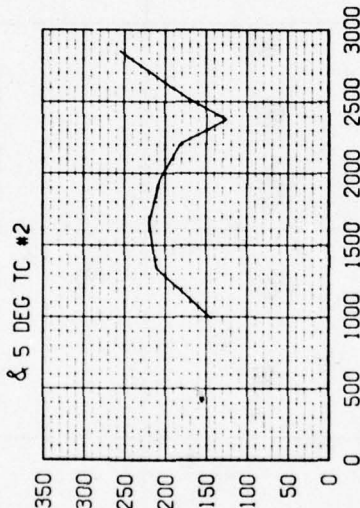
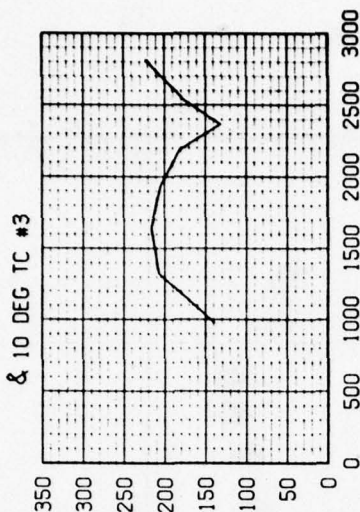


AD021 RUN 8 MODEL TI-2 CLEAR
 MODEL HEMI P0 = 1004 T0 = 6020
 Time = 9.16 to 12.50 Sec

◇ 10 DEG TC #4
 □ 10 DEG TC #3
 △ 5 DEG TC #2
 ○ 0 DEG TC #1

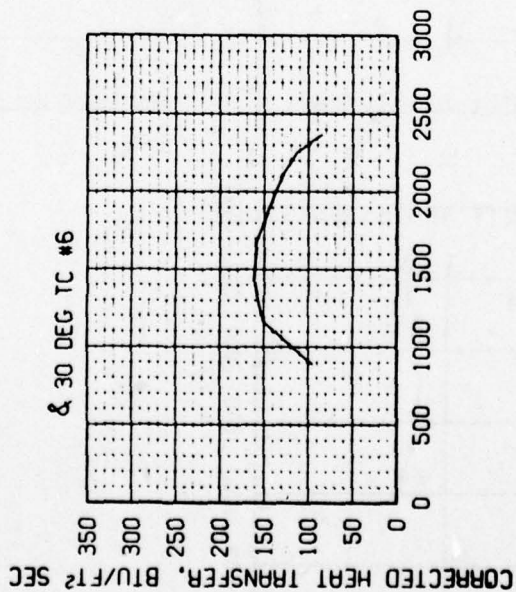
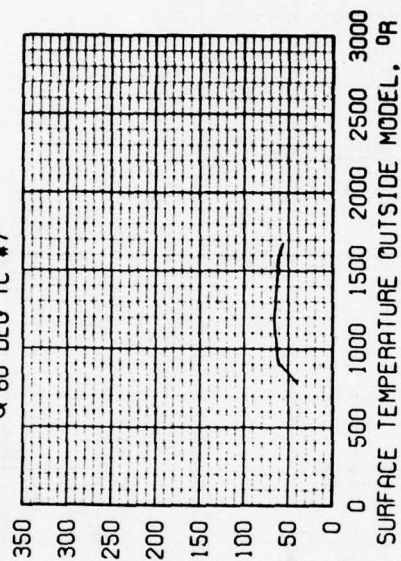


AD021 RUN 8 MODEL TI-18 DUST
 MODEL HEMI P0 = 1004 T0 = 6020
 Time = 17.11 to 19.20 Sec

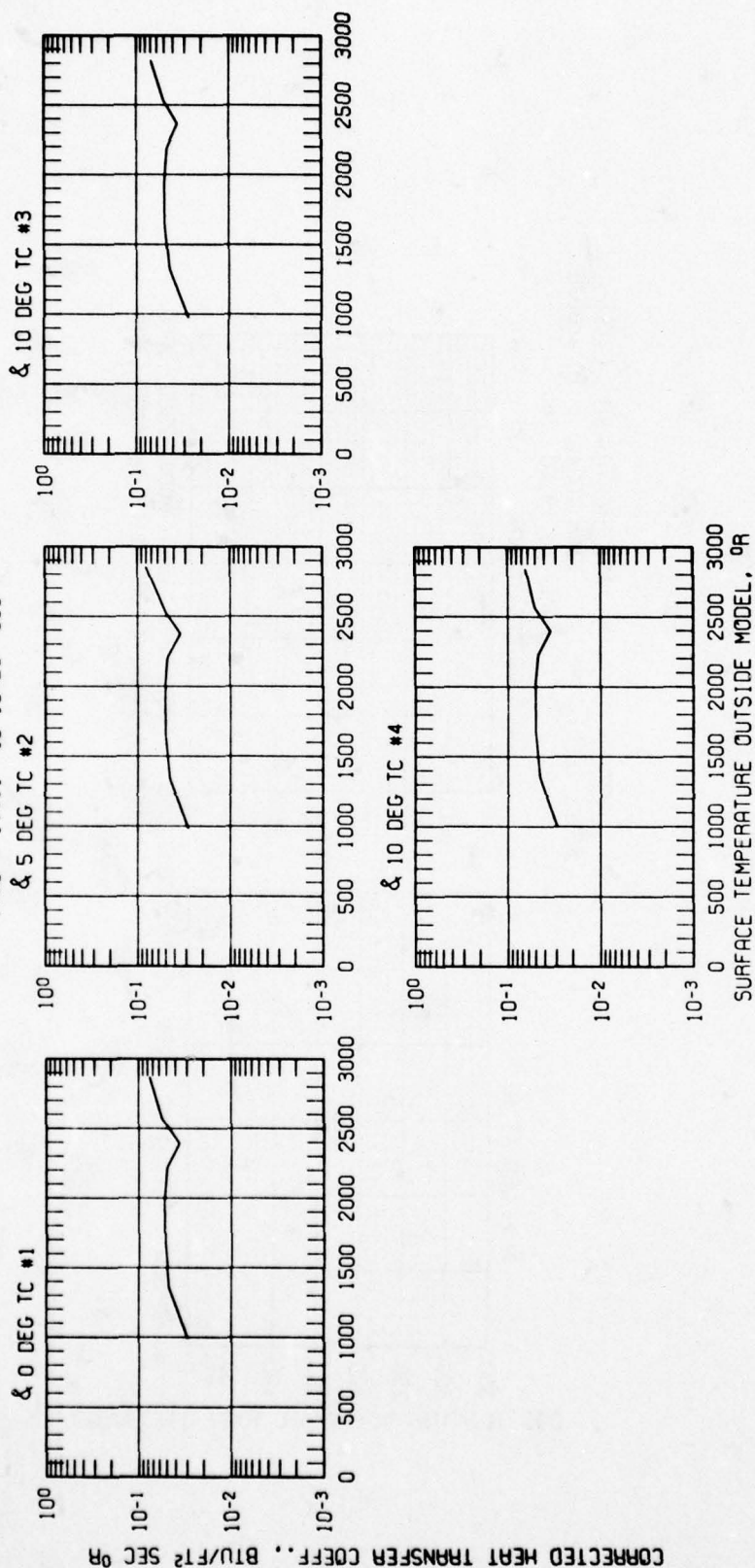


0 500 1000 1500 2000 2500 3000
 SURFACE TEMPERATURE OUTSIDE MODEL, °R

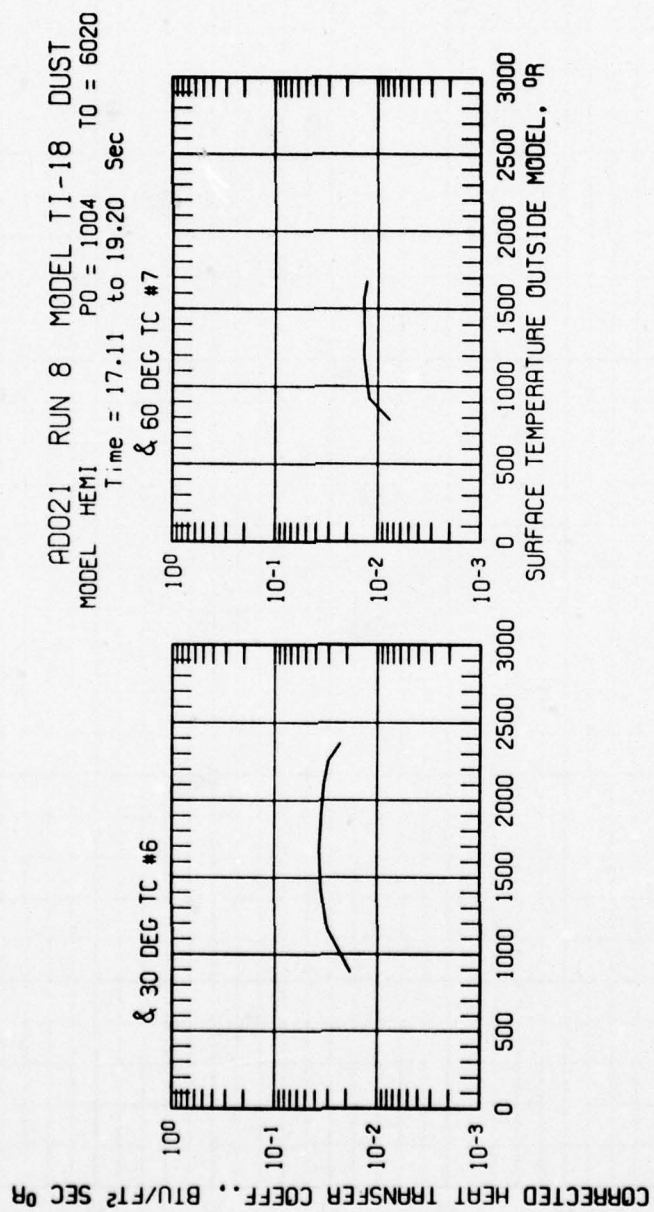
AD021 RUN 8 MODEL T1-18 DUST
 MODEL HEMI P0 = 1004 T0 = 6020
 Time = 17.11 to 19.20 Sec
 & 60 DEG TC #7



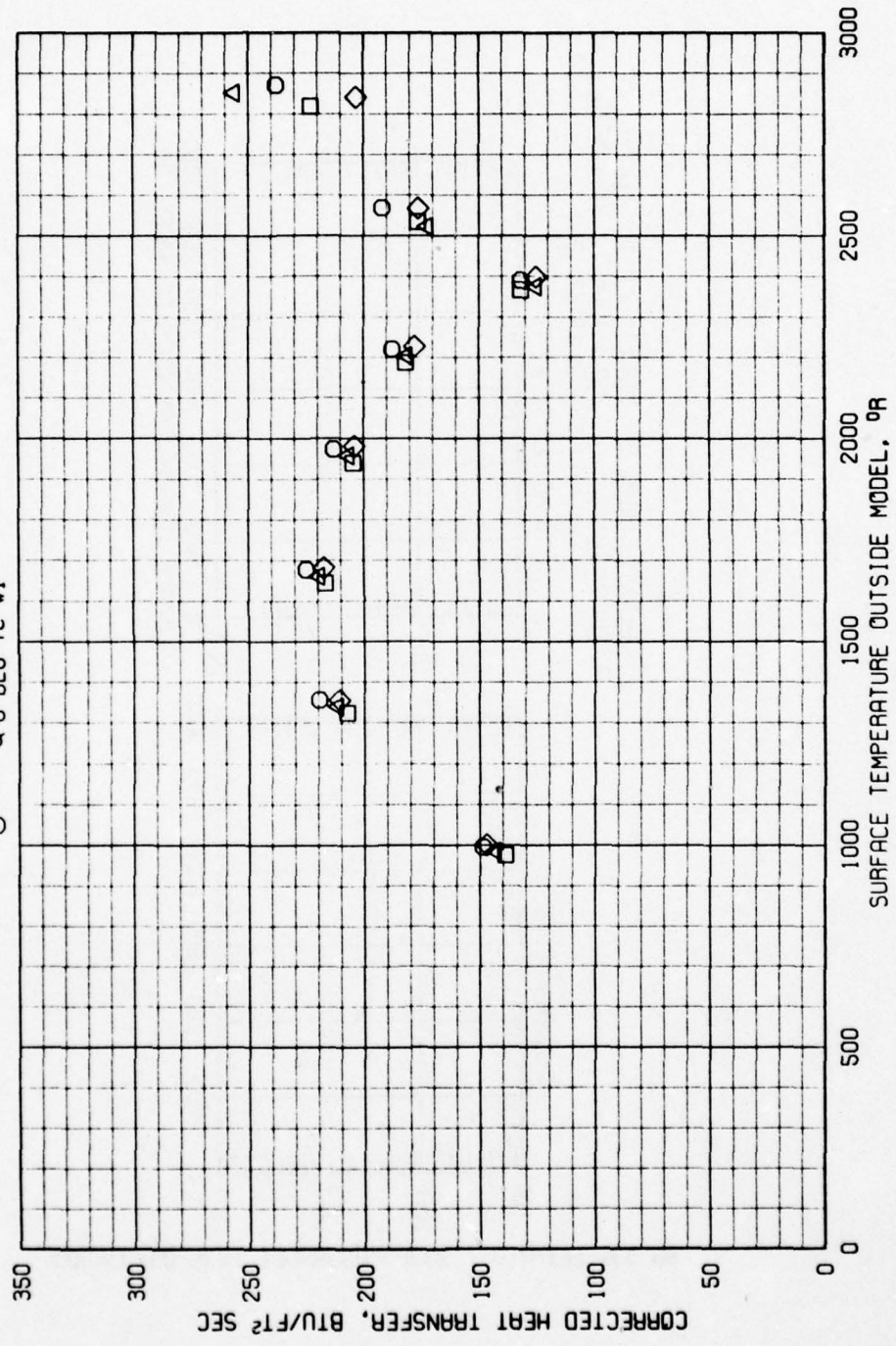
AD021 RUN 8 MODEL T1-18 DUST
 MODEL HEMI PO = 1004 T0 = 6020
 Time = 17.11 to 19.20 Sec



CORRECTED HEAT TRANSFER COEFF., BTU/FT² SEC θ_R

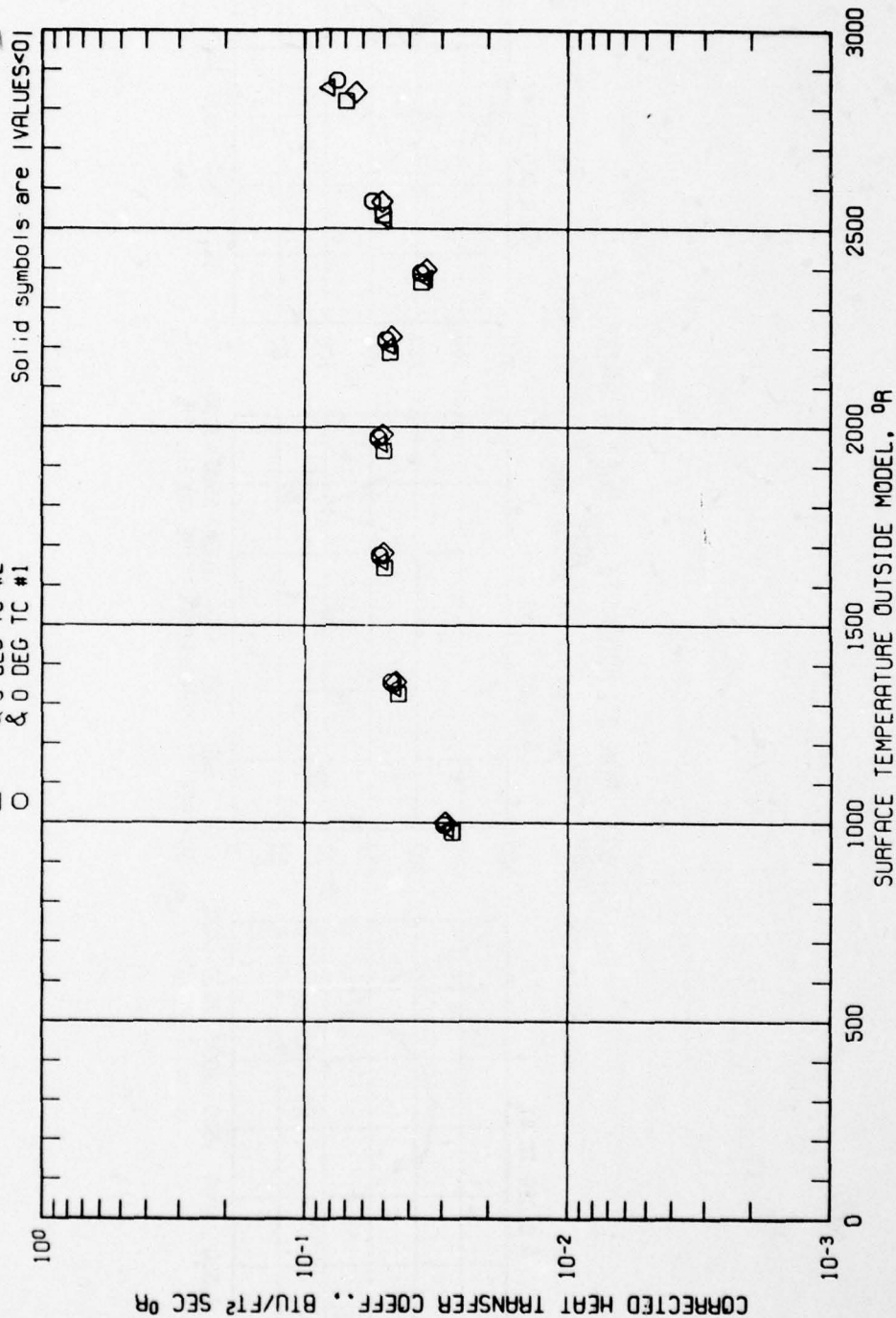


AD021 RUN 8 MODEL TI-18 DUST
 MODEL HEMI PO = 1004 T0 = 6020
 Time = 17.11 to 19.20 Sec
 & 10 DEG TC #4
 & 10 DEG TC #3
 & 5 DEG TC #2
 & 0 DEG TC #1

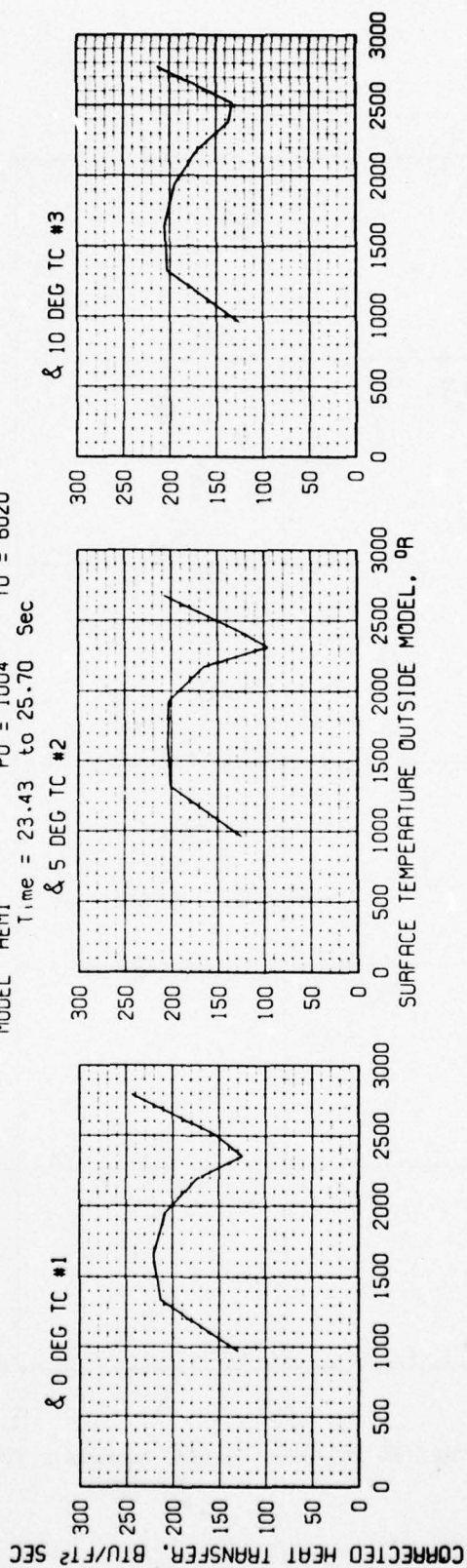


AD021 RUN 8 MODEL TI-18 DUST
 MODEL HEMI PO = 1004 TO = 6020
 Time = 17.11 to 19.20 Sec

◇ 10 DEG TC #4
 □ 10 DEG TC #3
 △ 5 DEG TC #2
 ○ 0 DEG TC #1

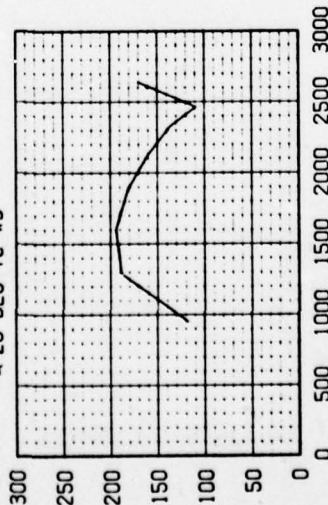


AD021 RUN 8 MODEL TI-7 DUST + WATER
 MODEL HEMI PO = 1004 TO = 6020
 Time = 23.43 to 25.70 Sec

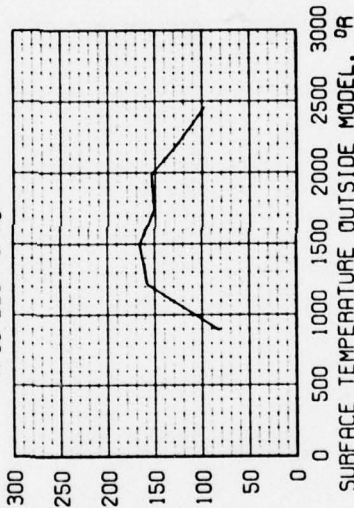


CORRECTED HEAT TRANSFER, BTU/FT² SEC

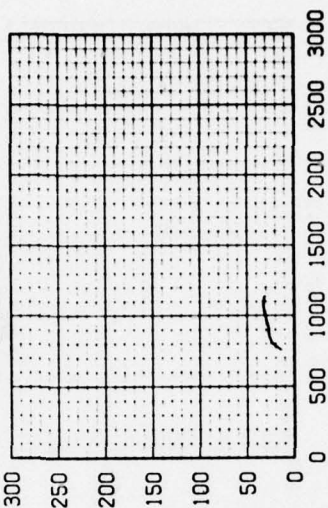
& 20 DEG TC #5



& 30 DEG TC #6

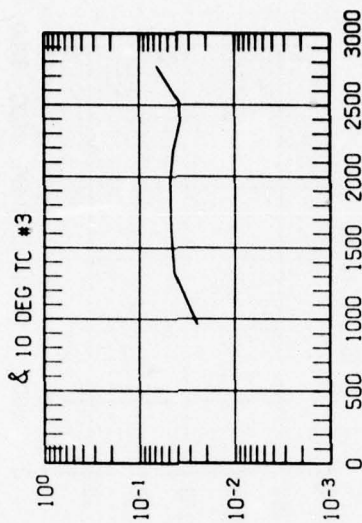
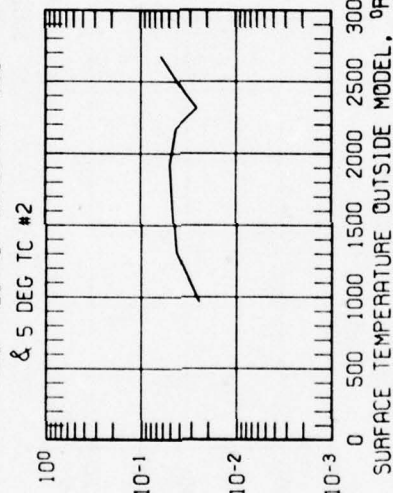
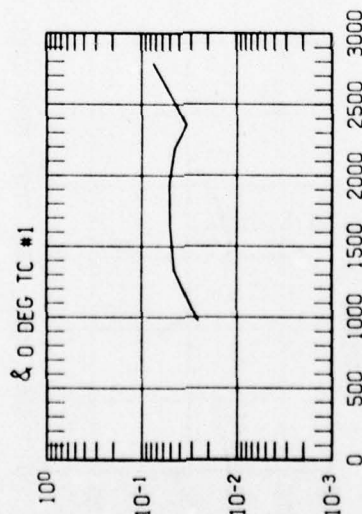


& 75 DEG TC #8



AD021 RUN 8 MODEL T1-7 DUST + WATER
MODEL HEM1 P0 = 1004 T0 = 6020
Time = 23.43 to 25.70 Sec

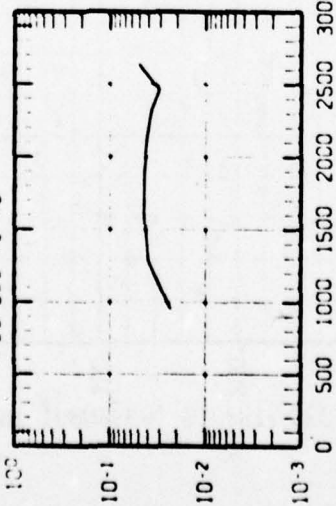
CORRECTED HEAT TRANSFER COEFF., BTU/FT² SEC °R



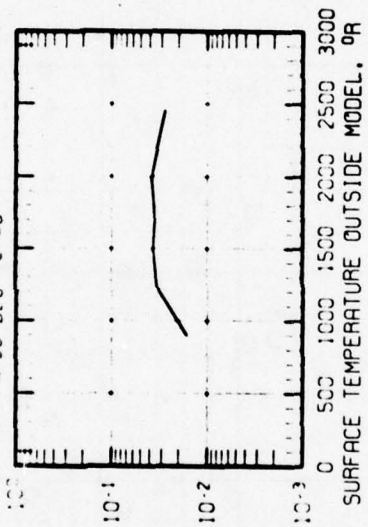
AD021 RUN 8 MODEL T1-7, DUST + WATER
 MODEL HEM1 P0 = 1004 T0 = 6020
 Time = 23.43 to 25.70 Sec

CORRECTED HEAT TRANSFER COEFF., BTU/FT² SEC °R

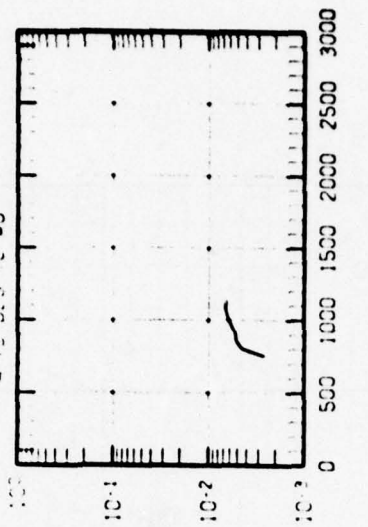
Δ 20 DEG TC #5



Δ 30 DEG TC #6



Δ 75 DEG TC #8

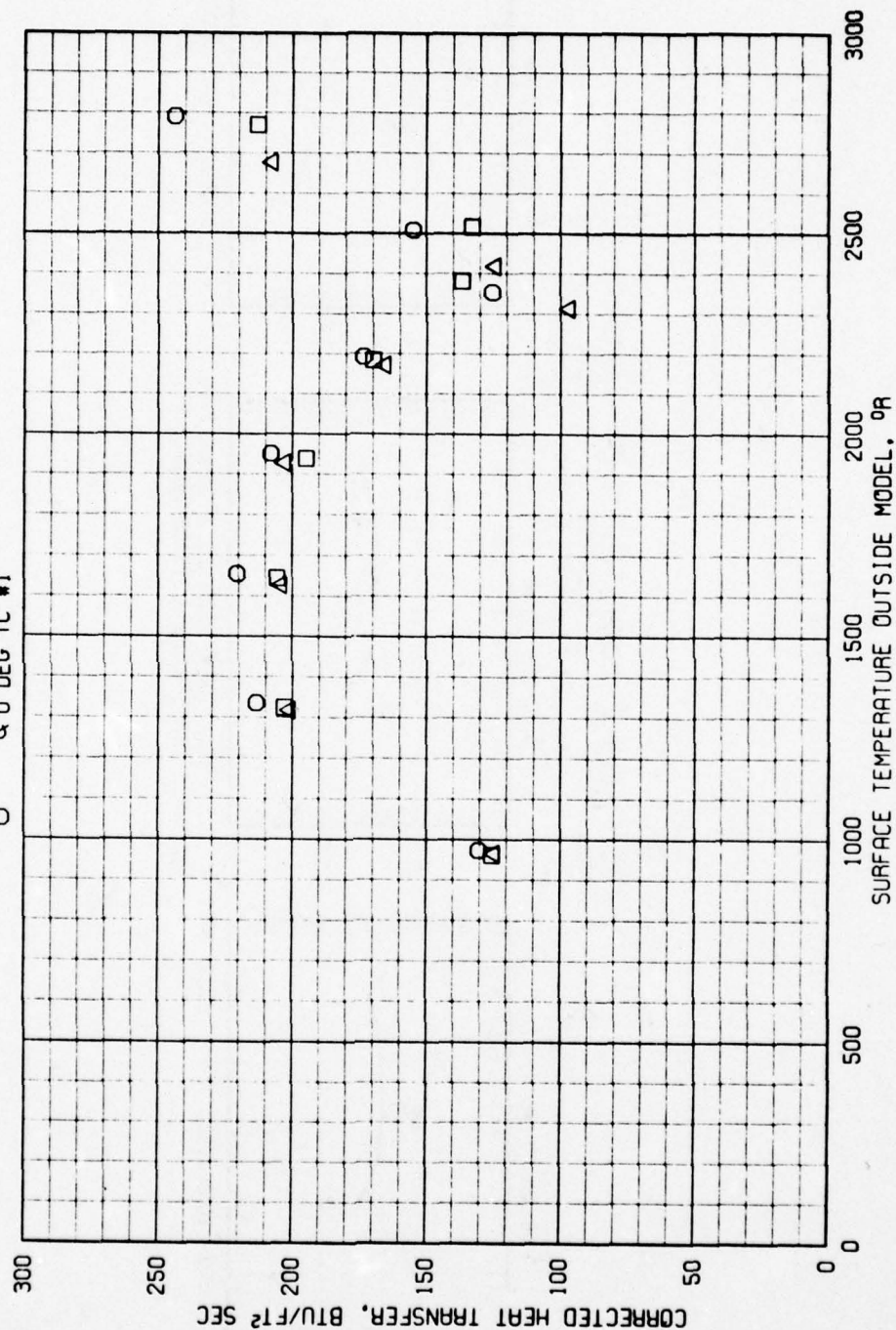


AD021 RUN 8 MODEL 11-7 DUST • WATER
MODEL HEMI PO = 1004 TO = 6020
Time = 23.43 to 25.70 Sec

SURFACE TEMPERATURE OUTSIDE MODEL, °R

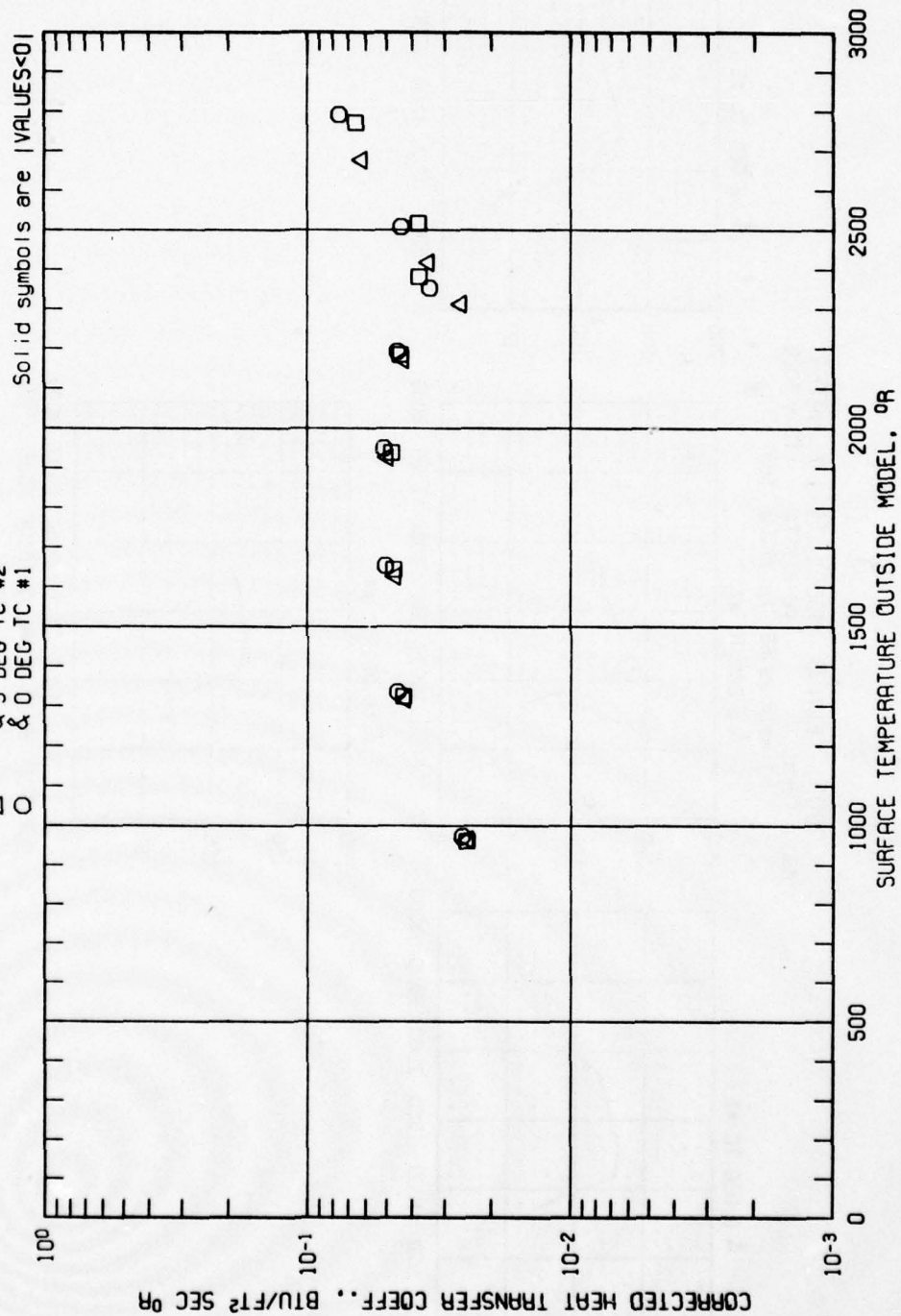
AD021 RUN 8 MODEL TI-7 DUST + WATER
 MODEL HEMI PO = 1004 TO = 6020
 Time = 23.43 to 25.70 Sec

□ & 10 DEG TC #3
 △ & 5 DEG TC #2
 ○ & 0 DEG TC #1

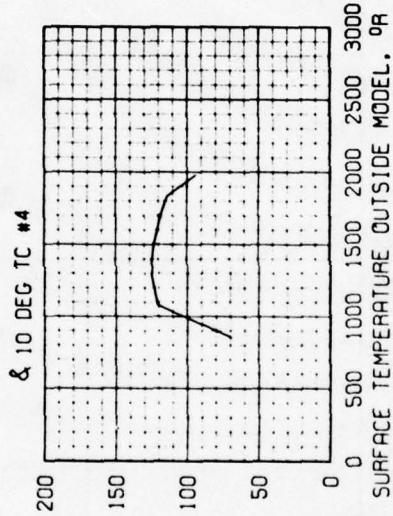
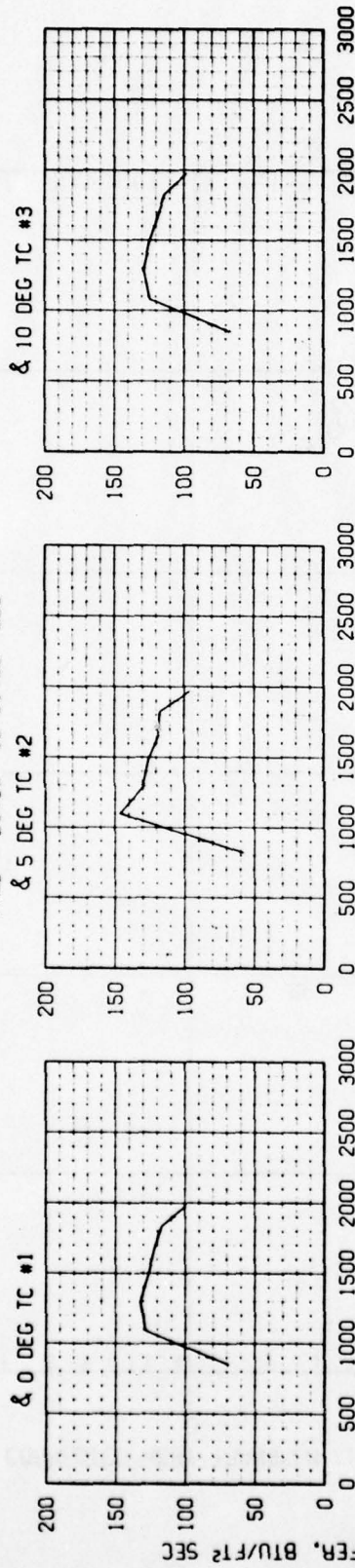


A0021 RUN 8 MODEL TI-7 DUST + WATER
 MODEL HEMI PO = 1004 TO = 6020
 Time = 23.43 to 25.70 Sec

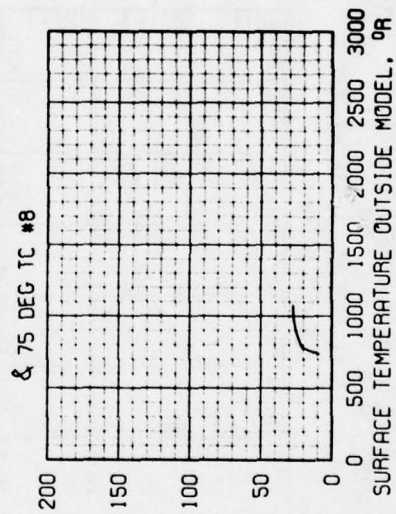
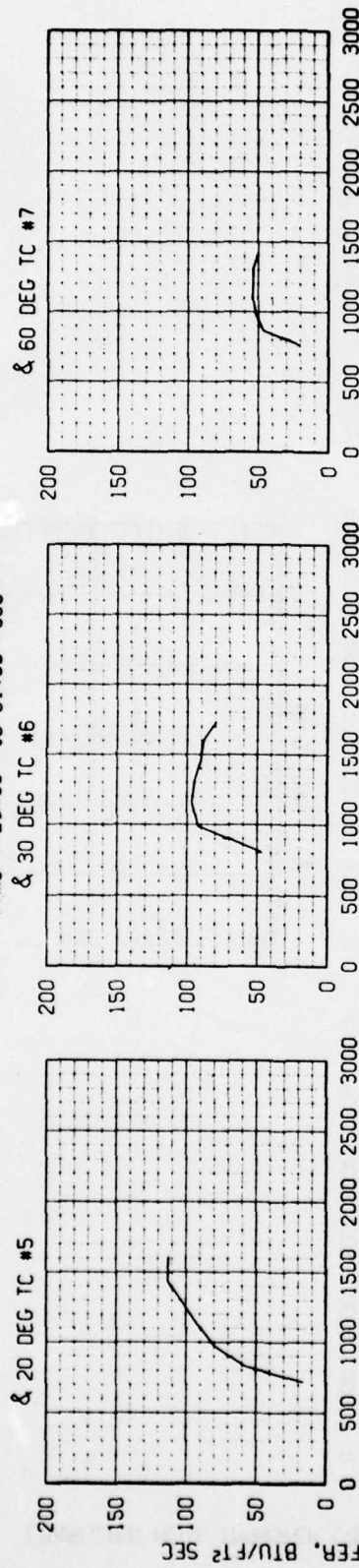
□ 10 DEG TC #3
 △ 5 DEG TC #2
 ○ 0 DEG TC #1



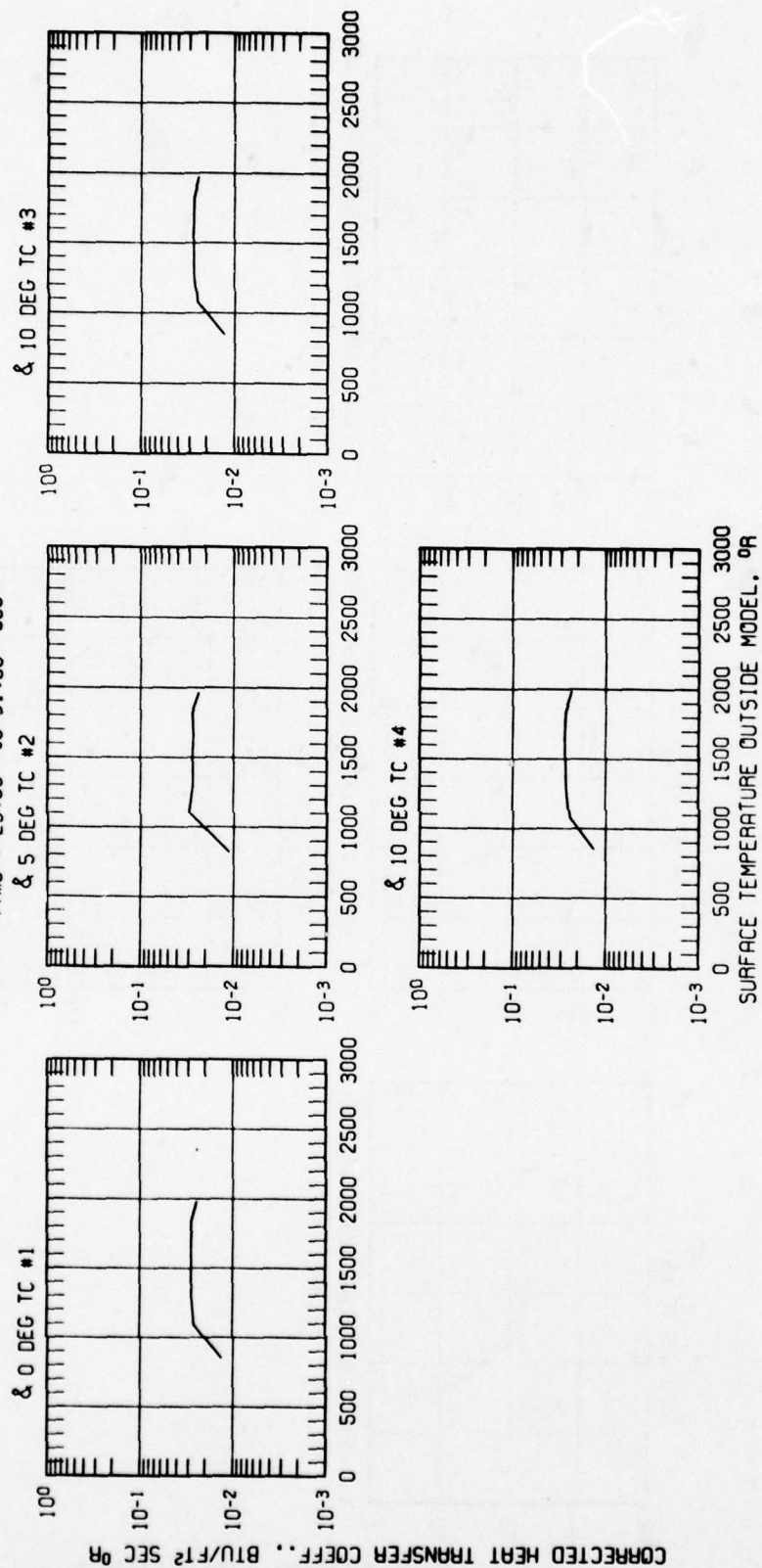
AD0021 RUN 8 MODEL TI-17 WATER
 MODEL HEMI P0 = 1004 T0 = 6020
 Time = 29.65 to 31.50 Sec



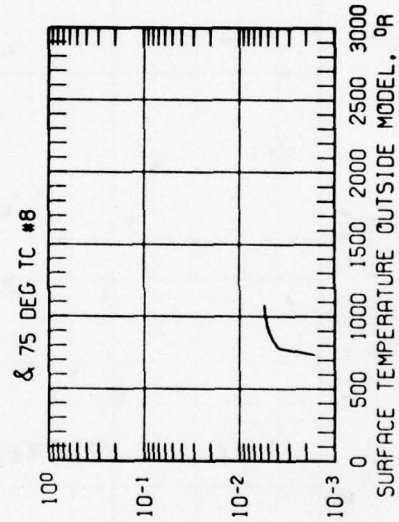
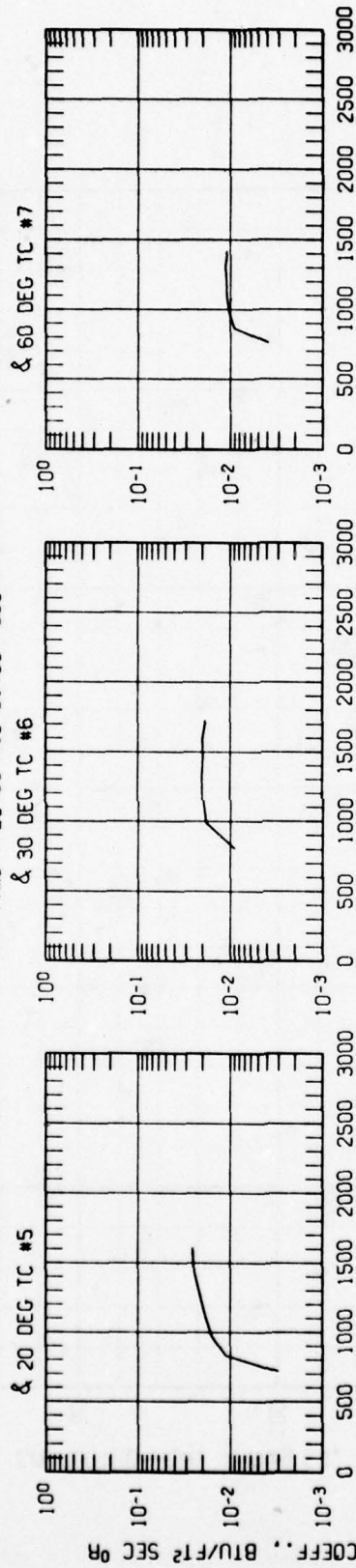
AD021 RUN 8 MODEL TI-17 WATER
 MODEL HEMI P0 = 1004 T0 = 6020
 Time = 29.65 to 31.50 Sec



AD021 RUN 8 MODEL TI-17 WATER
 MODEL HEMI P0 = 1004 T0 = 6020
 Time = 29.65 to 31.50 Sec



AD021 RUN 8 MODEL TI-17 WATER
 MODEL HEM1 P0 = 1004 T0 = 6020
 Time = 29.65 to 31.50 Sec



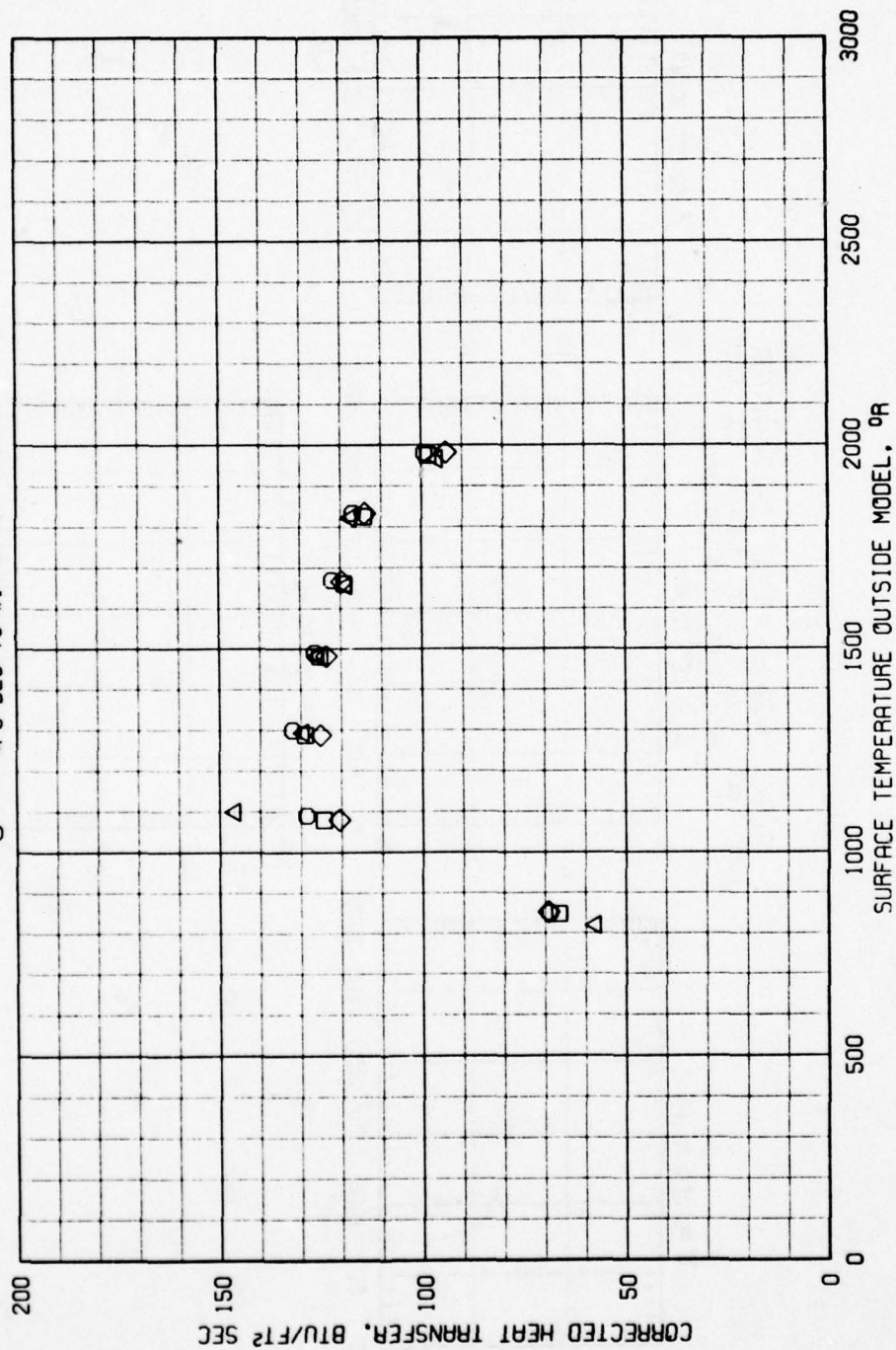
SURFACE TEMPERATURE OUTSIDE MODEL, °R

CORRECTED HEAT TRANSFER COEFF., BTU/FT² SEC °R

AD021 RUN 8 MODEL TI-17 WATER
 MODEL HEMI P0 = 1004 T0 = 6020

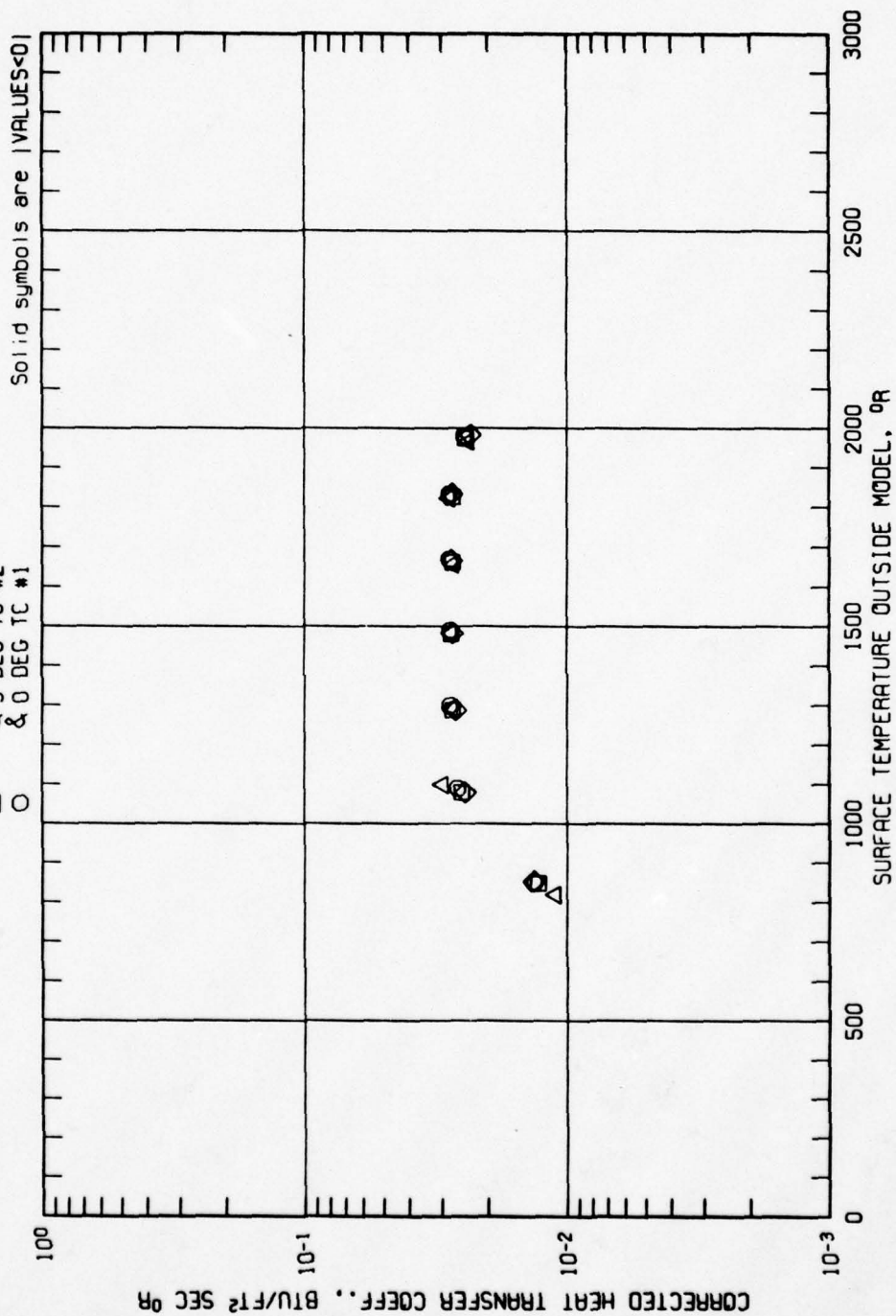
Time = 29.65 to 31.50 Sec

- ◇ 10 DEG TC #4
- 10 DEG TC #3
- △ 5 DEG TC #2
- 0 DEG TC #1



AD0021 RUN 8 MODEL TI-17 WATER
 MODEL HEMI P0 = 1004 T0 = 6020
 Time = 29.65 to 31.50 Sec

◇ 10 DEG TC #4
 □ 10 DEG TC #3
 △ 5 DEG TC #2
 ○ 0 DEG TC #1



APPENDIX B

SAI OXIDATION TEST DATA

SERIES 1

OXIDATION TESTS

JANUARY 1977

TITANIUM OXIDATION RUN SUMMARY: SERIES 1, JANUARY 1977

RUN NO.	SAMPLE GEOMETRY	THERMOCOUPLE TYPE	NOMINAL TEMP (°K)	NOMINAL TIME (MIN)	PRESSURE (atm)	GAS COMPOSITION	WEIGHT GAIN (mg)	CHART SPEED	COMMENTS
4	Disc	E	1200	3	0.5	He	2.0	2"/m	
5	Disc	E	1200	3	0.5	He	1.4	2"/m	Good vacuum
6	Disc	E	1200	3	0.5	Arg.	2.0	2"/m	
7	Disc	E	1200	5	0.5	O ₂	7.2	2"/m	Start heat in O ₂
8	Disc	E	1200	1.5	0.5	O ₂	1.6	2"/m	Noisy trace
9	Rect	S	1000	10	0.5	O ₂	1.1	2"/m	Did not reach 1200 only 1000. Must re-set machine for high.
10	Rect	S	1200	5	0.5	O ₂	5.4	2"/m	Had arc-over
11	Rect	S	1500	1.5	0.5	O ₂	22.7	6"/m	Temp overshoot to ~1600
12	Rect	S	1500	1.5	0.5	H ₂ O	35 +	6"/m	Lost some flakes
15	Rect	S	1200	~7	0.5	H ₂ O	5.4	6"/m	
16	Rect	S	1200	5	0.5	Air	4.2	6"/m	Strip chart not available
17	Rect	S	1200	5	0.1	Air	6.2	6"/m	Strip chart not available
18	Rect	S	1500	1.5	0.5	50/50H ₂ O-Air	15	6"/m	Some flakes lost

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NICKEL-CHROMIUM vs. COPPER-NICKEL
(Chromel-Constantan)

TYPE E

Temperature in Degrees C

Reference Junction at 0°C

DEG C	0	1	2	3	4	5	6	7	8	9	10	DEG C
THERMOELECTRIC VOLTAGE IN ABSOLUTE MILLIVOLTS												
-270	-9.855											-270
-260	-9.787	-9.802	-9.808	-9.813	-9.817	-9.821	-9.825	-9.828	-9.831	-9.833	-9.835	-260
-250	-9.719	-9.728	-9.737	-9.746	-9.754	-9.762	-9.770	-9.777	-9.784	-9.791	-9.797	-250
-240	-9.650	-9.617	-9.630	-9.642	-9.654	-9.666	-9.677	-9.688	-9.699	-9.709	-9.719	-240
-230	-9.585	-9.612	-9.620	-9.633	-9.645	-9.657	-9.669	-9.680	-9.691	-9.701	-9.711	-230
-220	-9.524	-9.593	-9.603	-9.612	-9.623	-9.634	-9.645	-9.656	-9.667	-9.677	-9.687	-220
-210	-9.463	-9.505	-9.507	-9.517	-9.527	-9.537	-9.547	-9.557	-9.567	-9.577	-9.587	-210
-200	-9.402	-9.474	-9.476	-9.485	-9.495	-9.505	-9.515	-9.525	-9.535	-9.545	-9.555	-200
-190	-9.341	-9.408	-9.413	-9.422	-9.432	-9.441	-9.451	-9.461	-9.471	-9.481	-9.491	-190
-180	-9.280	-9.350	-9.355	-9.364	-9.373	-9.383	-9.393	-9.403	-9.413	-9.423	-9.433	-180
-170	-9.219	-9.293	-9.297	-9.306	-9.315	-9.325	-9.335	-9.345	-9.355	-9.365	-9.375	-170
-160	-9.158	-9.237	-9.241	-9.250	-9.259	-9.269	-9.279	-9.289	-9.299	-9.309	-9.319	-160
-150	-9.097	-9.179	-9.183	-9.192	-9.201	-9.211	-9.221	-9.231	-9.241	-9.251	-9.261	-150
-140	-9.036	-9.119	-9.123	-9.132	-9.141	-9.151	-9.161	-9.171	-9.181	-9.191	-9.201	-140
-130	-8.975	-9.059	-9.063	-9.072	-9.081	-9.091	-9.101	-9.111	-9.121	-9.131	-9.141	-130
-120	-8.914	-8.998	-9.002	-9.011	-9.021	-9.031	-9.041	-9.051	-9.061	-9.071	-9.081	-120
-110	-8.853	-8.937	-8.941	-8.950	-8.960	-8.970	-8.980	-8.990	-9.000	-9.010	-9.020	-110
-100	-8.792	-8.876	-8.880	-8.889	-8.899	-8.909	-8.919	-8.929	-8.939	-8.949	-8.959	-100
-90	-8.731	-8.815	-8.819	-8.828	-8.838	-8.848	-8.858	-8.868	-8.878	-8.888	-8.898	-90
-80	-8.670	-8.754	-8.758	-8.767	-8.777	-8.787	-8.797	-8.807	-8.817	-8.827	-8.837	-80
-70	-8.609	-8.693	-8.697	-8.706	-8.716	-8.726	-8.736	-8.746	-8.756	-8.766	-8.776	-70
-60	-8.548	-8.632	-8.636	-8.645	-8.655	-8.665	-8.675	-8.685	-8.695	-8.705	-8.715	-60
-50	-8.487	-8.571	-8.575	-8.584	-8.594	-8.604	-8.614	-8.624	-8.634	-8.644	-8.654	-50
-40	-8.426	-8.510	-8.514	-8.523	-8.533	-8.543	-8.553	-8.563	-8.573	-8.583	-8.593	-40
-30	-8.365	-8.449	-8.453	-8.462	-8.472	-8.482	-8.492	-8.502	-8.512	-8.522	-8.532	-30
-20	-8.304	-8.388	-8.392	-8.401	-8.411	-8.421	-8.431	-8.441	-8.451	-8.461	-8.471	-20
-10	-8.243	-8.327	-8.331	-8.340	-8.350	-8.360	-8.370	-8.380	-8.390	-8.400	-8.410	-10
0	0.000	0.009	0.017	0.026	0.035	0.044	0.053	0.062	0.071	0.080	0.089	0
10	0.098	0.107	0.115	0.124	0.133	0.142	0.151	0.160	0.169	0.178	0.187	10
20	0.196	0.205	0.213	0.222	0.231	0.240	0.249	0.258	0.267	0.276	0.285	20
30	0.294	0.303	0.311	0.320	0.329	0.338	0.347	0.356	0.365	0.374	0.383	30
40	0.392	0.401	0.409	0.418	0.427	0.436	0.445	0.454	0.463	0.472	0.481	40
50	0.489	0.498	0.506	0.515	0.524	0.533	0.542	0.551	0.560	0.569	0.578	50
60	0.586	0.595	0.603	0.612	0.621	0.630	0.639	0.648	0.657	0.666	0.675	60
70	0.683	0.692	0.700	0.709	0.718	0.727	0.736	0.745	0.754	0.763	0.772	70
80	0.780	0.789	0.797	0.806	0.815	0.824	0.833	0.842	0.851	0.860	0.869	80
90	0.877	0.886	0.894	0.903	0.912	0.921	0.930	0.939	0.948	0.957	0.966	90
100	0.974	0.983	0.991	1.000	1.009	1.018	1.027	1.036	1.045	1.054	1.063	100
110	1.071	1.080	1.089	1.098	1.107	1.116	1.125	1.134	1.143	1.152	1.161	110
120	1.169	1.178	1.187	1.196	1.205	1.214	1.223	1.232	1.241	1.250	1.259	120
130	1.267	1.276	1.285	1.294	1.303	1.312	1.321	1.330	1.339	1.348	1.357	130
140	1.365	1.374	1.383	1.392	1.401	1.410	1.419	1.428	1.437	1.446	1.455	140
150	1.463	1.472	1.481	1.490	1.499	1.508	1.517	1.526	1.535	1.544	1.553	150
160	1.561	1.570	1.579	1.588	1.597	1.606	1.615	1.624	1.633	1.642	1.651	160
170	1.659	1.668	1.677	1.686	1.695	1.704	1.713	1.722	1.731	1.740	1.749	170
180	1.757	1.766	1.775	1.784	1.793	1.802	1.811	1.820	1.829	1.838	1.847	180
190	1.855	1.864	1.873	1.882	1.891	1.900	1.909	1.918	1.927	1.936	1.945	190
200	1.953	1.962	1.971	1.980	1.989	1.998	2.007	2.016	2.025	2.034	2.043	200
210	2.051	2.060	2.069	2.078	2.087	2.096	2.105	2.114	2.123	2.132	2.141	210
220	2.149	2.158	2.167	2.176	2.185	2.194	2.203	2.212	2.221	2.230	2.239	220
230	2.247	2.256	2.265	2.274	2.283	2.292	2.301	2.310	2.319	2.328	2.337	230
240	2.345	2.354	2.363	2.372	2.381	2.390	2.399	2.408	2.417	2.426	2.435	240
250	2.443	2.452	2.461	2.470	2.479	2.488	2.497	2.506	2.515	2.524	2.533	250
260	2.541	2.550	2.559	2.568	2.577	2.586	2.595	2.604	2.613	2.622	2.631	260
270	2.639	2.648	2.657	2.666	2.675	2.684	2.693	2.702	2.711	2.720	2.729	270
280	2.737	2.746	2.755	2.764	2.773	2.782	2.791	2.800	2.809	2.818	2.827	280
290	2.835	2.844	2.853	2.862	2.871	2.880	2.889	2.898	2.907	2.916	2.925	290
300	2.933	2.942	2.951	2.960	2.969	2.978	2.987	2.996	3.005	3.014	3.023	300
310	3.031	3.040	3.049	3.058	3.067	3.076	3.085	3.094	3.103	3.112	3.121	310
320	3.129	3.138	3.147	3.156	3.165	3.174	3.183	3.192	3.201	3.210	3.219	320
330	3.227	3.236	3.245	3.254	3.263	3.272	3.281	3.290	3.299	3.308	3.317	330
340	3.325	3.334	3.343	3.352	3.361	3.370	3.379	3.388	3.397	3.406	3.415	340
350	3.423	3.432	3.441	3.450	3.459	3.468	3.477	3.486	3.495	3.504	3.513	350
360	3.521	3.530	3.539	3.548	3.557	3.566	3.575	3.584	3.593	3.602	3.611	360
370	3.619	3.628	3.637	3.646	3.655	3.664	3.673	3.682	3.691	3.700	3.709	370
380	3.717	3.726	3.735	3.744	3.753	3.762	3.771	3.780	3.789	3.798	3.807	380
390	3.815	3.824	3.833	3.842	3.851	3.860	3.869	3.878	3.887	3.896	3.905	390
400	3.913	3.922	3.931	3.940	3.949	3.958	3.967	3.976	3.985	3.994	4.003	400
410	4.011	4.020	4.029	4.038	4.047	4.056	4.065	4.074	4.083	4.092	4.101	410
420	4.109	4.118	4.127	4.136	4.145	4.154	4.163	4.172	4.181	4.190	4.199	420
430	4.207	4.216	4.225	4.234	4.243	4.252	4.261	4.270	4.279	4.288	4.297	430
440	4.305	4.314	4.323	4.332	4.341	4.350	4.359	4.368	4.377	4.386	4.395	440
450	4.403	4.412	4.421	4.430	4.439	4.448	4.457	4.466	4.475	4.484	4.493	450
460	4.501	4.510	4.519	4.528	4.537	4.546	4.555	4.564	4.573	4.582	4.591	460
470	4.599	4.608	4.617	4.626	4.635	4.644	4.653	4.662	4.671	4.680	4.689	470
480	4.697	4.706	4.715	4.724	4.733	4.742	4.751	4.760	4.769	4.778	4.787	480
490	4.795	4.804	4.813	4.822	4.831	4.840	4.849	4.858	4.867	4.876	4.885	490
500	4.893	4.902	4.911	4.920	4.929	4.938	4.947	4.956	4.965	4.974	4.983	500
510	4.991	5.000	5.009	5.018	5.027	5.036	5.045	5.054	5.063	5.072	5.081	510
520	5.089	5.098	5.107	5.116	5.125	5.134	5.143	5.152	5.161	5.170	5.179	520
530	5.187	5.196	5.205	5.214	5.223	5.232	5.241	5.250	5.259	5.268	5.277	530
540	5.285	5.294	5.303	5.312	5.321	5.330	5.339	5.348	5.357	5.366	5.375	540
550	5.383	5.392	5.401	5.410	5.419	5.428	5.437	5.446	5.455	5.464	5.473	550
560	5.481	5.490	5.499	5.508	5.517	5.526	5.535	5.544	5.553	5.562	5.571	560
570	5.579	5.588	5.597	5.606	5.615	5.624	5.633	5.642	5.651	5.660	5.669	570
580	5.677	5.686	5.695	5.704	5.713	5.722	5.731	5.740	5.749	5.758	5.767	580
590	5.775	5.784	5.793	5.802	5.811	5.820	5.829	5.838	5.847	5.856	5.865	590
600	5.873	5.882	5.891	5.900	5.909	5.918	5.927	5.936	5.945	5.954	5.963	600
610	5.971	5.98.										

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NICKEL-CHROMIUM vs. COPPER-NICKEL (Chromel-Constantan)

TYPE E

Temperature in Degrees C

Reference Junction at 0°C

TYPE
E

NEW REFERENCE TABLES
SUPERSEDES N.B.S. CIRCULAR #361

DEG C	0	1	2	3	4	5	6	7	8	9	10	DEG C
THERMOELECTRIC VOLTAGE IN ABSOLUTE MILLIVOLTS												
800	61.022	61.101	61.179	61.258	61.336	61.414	61.493	61.571	61.649	61.728	61.806	800
810	61.806	61.884	61.962	62.041	62.119	62.197	62.275	62.353	62.432	62.510	62.588	810
820	62.588	62.666	62.744	62.822	62.900	62.978	63.056	63.134	63.212	63.290	63.368	820
830	63.368	63.446	63.524	63.602	63.680	63.758	63.836	63.914	63.992	64.070	64.148	830
840	64.147	64.225	64.303	64.380	64.458	64.536	64.614	64.691	64.769	64.847	64.924	840
850	64.924	65.002	65.080	65.157	65.235	65.312	65.390	65.467	65.545	65.622	65.700	850
860	65.700	65.777	65.855	65.932	66.009	66.087	66.164	66.241	66.319	66.396	66.473	860
870	66.473	66.551	66.628	66.705	66.782	66.859	66.937	67.014	67.091	67.168	67.245	870
880	67.245	67.322	67.399	67.476	67.553	67.630	67.707	67.784	67.861	67.938	68.015	880
890	68.015	68.092	68.169	68.246	68.323	68.399	68.476	68.553	68.630	68.706	68.783	890
900	68.783	68.860	68.936	69.013	69.090	69.166	69.243	69.320	69.396	69.473	69.549	900
910	69.549	69.626	69.702	69.779	69.855	69.931	70.008	70.084	70.161	70.237	70.313	910
920	70.313	70.390	70.466	70.542	70.618	70.694	70.771	70.847	70.923	71.000	71.075	920
930	71.075	71.151	71.227	71.303	71.380	71.456	71.532	71.608	71.683	71.759	71.835	930
940	71.835	71.911	71.987	72.063	72.139	72.215	72.290	72.366	72.442	72.518	72.593	940
950	72.593	72.669	72.745	72.820	72.896	72.972	73.047	73.123	73.199	73.274	73.350	950
960	73.350	73.425	73.501	73.576	73.652	73.727	73.802	73.878	73.953	74.029	74.104	960
970	74.104	74.179	74.255	74.330	74.405	74.480	74.556	74.631	74.706	74.781	74.857	970
980	74.857	74.932	75.007	75.082	75.157	75.232	75.307	75.382	75.458	75.533	75.608	980
990	75.608	75.683	75.758	75.833	75.908	75.983	76.058	76.133	76.208	76.283	76.358	990
1,000	76.358											1,000

COPPER vs. COPPER-NICKEL (Copper-Constantan)

TYPE T

Temperature in Degrees C

Reference Junction at 0°C

TYPE
T

NEW REFERENCE TABLES
SUPERSEDES N.B.S. CIRCULAR #361

DEG C	0	1	2	3	4	5	6	7	8	9	10	DEG C
THERMOELECTRIC VOLTAGE IN ABSOLUTE MILLIVOLTS												
-270	-6.258											-270
-240	-6.232	-6.236	-6.239	-6.242	-6.245	-6.248	-6.251	-6.253	-6.255	-6.256	-6.258	-240
-250	-6.181	-6.187	-6.193	-6.198	-6.204	-6.209	-6.214	-6.219	-6.224	-6.228	-6.232	-250
-240	-6.105	-6.114	-6.122	-6.130	-6.138	-6.146	-6.153	-6.160	-6.167	-6.174	-6.181	-240
-230	-6.007	-6.018	-6.028	-6.039	-6.049	-6.059	-6.068	-6.078	-6.087	-6.096	-6.105	-230
-220	-5.889	-5.901	-5.914	-5.926	-5.938	-5.950	-5.962	-5.973	-5.984	-5.995	-6.006	-220
-210	-5.753	-5.767	-5.782	-5.795	-5.809	-5.823	-5.836	-5.850	-5.863	-5.876	-5.889	-210
-200	-5.603	-5.619	-5.634	-5.650	-5.665	-5.680	-5.695	-5.710	-5.724	-5.739	-5.753	-200
-190	-5.439	-5.456	-5.473	-5.489	-5.506	-5.522	-5.539	-5.555	-5.571	-5.587	-5.603	-190
-180	-5.261	-5.279	-5.297	-5.315	-5.333	-5.351	-5.369	-5.387	-5.404	-5.421	-5.439	-180
-170	-5.089	-5.089	-5.109	-5.128	-5.147	-5.167	-5.186	-5.205	-5.223	-5.242	-5.261	-170
-160	-4.865	-4.886	-4.907	-4.928	-4.948	-4.969	-4.989	-5.010	-5.030	-5.050	-5.069	-160
-150	-4.648	-4.670	-4.693	-4.715	-4.737	-4.758	-4.780	-4.801	-4.823	-4.844	-4.865	-150
-140	-4.419	-4.442	-4.466	-4.489	-4.512	-4.535	-4.558	-4.581	-4.603	-4.626	-4.648	-140
-130	-4.177	-4.202	-4.226	-4.251	-4.275	-4.299	-4.323	-4.347	-4.371	-4.395	-4.419	-130
-120	-3.923	-3.949	-3.974	-4.000	-4.026	-4.051	-4.077	-4.102	-4.127	-4.152	-4.177	-120
-110	-3.656	-3.684	-3.711	-3.737	-3.764	-3.791	-3.818	-3.844	-3.870	-3.897	-3.923	-110
-100	-3.378	-3.407	-3.435	-3.463	-3.491	-3.519	-3.547	-3.574	-3.602	-3.629	-3.656	-100
-90	-3.089	-3.118	-3.147	-3.177	-3.206	-3.235	-3.264	-3.293	-3.321	-3.350	-3.378	-90
-80	-2.788	-2.818	-2.849	-2.879	-2.909	-2.939	-2.970	-2.999	-3.029	-3.059	-3.089	-80
-70	-2.475	-2.507	-2.539	-2.570	-2.602	-2.633	-2.664	-2.695	-2.726	-2.757	-2.788	-70
-60	-2.152	-2.185	-2.218	-2.250	-2.283	-2.315	-2.348	-2.380	-2.412	-2.444	-2.475	-60
-50	-1.819	-1.853	-1.886	-1.920	-1.953	-1.987	-2.020	-2.053	-2.087	-2.120	-2.152	-50
-40	-1.475	-1.510	-1.544	-1.579	-1.614	-1.648	-1.682	-1.717	-1.751	-1.785	-1.819	-40
-30	-1.121	-1.157	-1.192	-1.228	-1.263	-1.299	-1.334	-1.370	-1.405	-1.440	-1.475	-30
-20	-0.757	-0.794	-0.830	-0.867	-0.903	-0.940	-0.976	-1.013	-1.049	-1.085	-1.121	-20
-10	-0.383	-0.421	-0.458	-0.496	-0.534	-0.571	-0.608	-0.646	-0.683	-0.720	-0.757	-10
0	0.000	-0.039	-0.077	-0.116	-0.154	-0.193	-0.231	-0.269	-0.307	-0.345	-0.383	0
DEG C	0	1	2	3	4	5	6	7	8	9	10	DEG C
0	0.000	0.039	0.078	0.117	0.156	0.195	0.234	0.273	0.312	0.351	0.391	0
10	0.391	0.430	0.470	0.510	0.549	0.589	0.629	0.669	0.709	0.749	0.789	10
20	0.789	0.830	0.870	0.911	0.951	0.991	1.032	1.073	1.114	1.155	1.196	20
30	1.196	1.237	1.279	1.320	1.361	1.403	1.444	1.486	1.528	1.569	1.611	30
40	1.611	1.653	1.695	1.738	1.780	1.822	1.865	1.907	1.950	1.992	2.035	40
50	2.035	2.078	2.121	2.164	2.207	2.250	2.294	2.337	2.380	2.424	2.467	50
60	2.467	2.511	2.555	2.599	2.643	2.687	2.731	2.775	2.819	2.864	2.908	60
70	2.908	2.953	2.997	3.042	3.087	3.131	3.176	3.221	3.266	3.312	3.357	70
80	3.357	3.402	3.447	3.493	3.538	3.584	3.630	3.676	3.721	3.767	3.813	80
90	3.813	3.859	3.906	3.952	3.998	4.044	4.091	4.137	4.184	4.231	4.277	90
100	4.277	4.324	4.371	4.418	4.465	4.512	4.559	4.607	4.654	4.701	4.749	100
110	4.749	4.796	4.844	4.891	4.939	4.987	5.035	5.083	5.131	5.179	5.227	110
120	5.227	5.275	5.324	5.372	5.420	5.468	5.517	5.566	5.615	5.663	5.712	120
130	5.712	5.761	5.810	5.859	5.908	5.957	6.007	6.056	6.105	6.155	6.204	130
140	6.204	6.254	6.303	6.353	6.403	6.452	6.502	6.552	6.602	6.652	6.702	140
150	6.702	6.753	6.803	6.853	6.903	6.954	7.004	7.055	7.106	7.156	7.207	150
160	7.207	7.258	7.309	7.360	7.411	7.462	7.513	7.564	7.615	7.666	7.718	160
170	7.718	7.769	7.821	7.872	7.924	7.975	8.027	8.079	8.131	8.183	8.235	170
180	8.235	8.287	8.339	8.391	8.443	8.495	8.548	8.600	8.652	8.705	8.757	180
190	8.757	8.810	8.863	8.915	8.968	9.021	9.074	9.127	9.180	9.233	9.286	190
200	9.286	9.339	9.392	9.446	9.499	9.553	9.606	9.659	9.713	9.767	9.820	200
210	9.820	9.874	9.928	9.982	10.036	10.090	10.144	10.198	10.252	10.306	10.360	210
220	10.360	10.414	10.469	10.523	10.578	10.632	10.687	10.741	10.796	10.851	10.905	220
230	10.905	10.960	11.015	11.070	11.125	11.180	11.235	11.290	11.345	11.401	11.456	230
240	11.456	11.511	11.566	11.622	11.677	11.733	11.788	11.844	11.900	11.956	12.011	240
250	12.011	12.067	12.123	12.179	12.235	12.291	12.347	12.403	12.459	12.515	12.572	250
260	12.572	12.628	12.684	12.741	12.797	12.854	12.910	12.967	13.024	13.080	13.137	260
270	13.137	13.194	13.251	13.307	13.364	13.421	13.478	13.535	13.592	13.650	13.707	270
280	13.707	13.764	13.821	13.879	13.936	13.993	14.051	14.108	14.166	14.223	14.281	280
290	14.281	14.339	14.396	14.454	14.512	14.570	14.628	14.686	14.744	14.802	14.860	290
300	14.860	14.918	14.976	15.034	15.092	15.151	15.209	15.267	15.326	15.384	15.443	300
310	15.443	15.501	15.560	15.618	15.677	15.735	15.795	15.853	15.912	15.971	16.030	310
320	16.030	16.089	16.148	16.207	16.266	16.325	16.384	16.443	16.503	16.562	16.621	320
330	16.621	16.681	16.740	16.800	16.859	16.919	16.978	17.039	17.097	17.157	17.217	330
340	17.217	17.277	17.336	17.396	17.456	17.516	17.576	17.636	17.696	17.756	17.816	340
350	17.816	17.877	17.937	17.997	18.057	18.118	18.178	18.238	18.299	18.359	18.420	350
360	18.420	18.480	18.541	18.601	18.662	18.723	18.784	18.845	18.905	18.966	19.027	360
370	19.027	19.088	19.148	19.209	19.269	19.330	19.390	19.451	19.511	19.572	19.632	370
380	19.632	19.693	19.754	19.814	19.875	19.936	20.000	20.060	20.120	20.181	20.242	380
390	20.242	20.303	20.363	20.424	20.485	20.546	20.627	20.688	20.749	20.809	20.870	390
400	20.870											400
DEG F	0	1	2	3	4	5	6	7	8	9	10	DEG F

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PLATINUM vs. PLATINUM-10% RHODIUM

TYPE S

Temperature in Degrees C

Reference Junction at 0°C

DEG C	0	1	2	3	4	5	6	7	8	9	10	DEG C
THERMOELECTRIC VOLTAGE IN ABSOLUTE MILLIVOLTS												
0	0.000	0.005	0.011	0.016	0.022	0.027	0.033	0.038	0.044	0.050	0.055	0
10	0.055	0.061	0.067	0.072	0.078	0.084	0.090	0.095	0.101	0.107	0.113	10
20	0.113	0.119	0.125	0.131	0.137	0.142	0.148	0.154	0.161	0.167	0.173	20
30	0.173	0.179	0.185	0.191	0.197	0.203	0.210	0.216	0.222	0.228	0.235	30
40	0.235	0.241	0.247	0.254	0.260	0.266	0.273	0.279	0.286	0.292	0.299	40
50	0.299	0.305	0.312	0.318	0.325	0.331	0.338	0.345	0.351	0.358	0.365	50
60	0.365	0.371	0.378	0.385	0.391	0.398	0.405	0.412	0.419	0.425	0.432	60
70	0.432	0.439	0.446	0.453	0.460	0.467	0.474	0.481	0.488	0.495	0.502	70
80	0.502	0.509	0.516	0.523	0.530	0.537	0.544	0.551	0.558	0.566	0.573	80
90	0.573	0.580	0.587	0.594	0.602	0.609	0.616	0.623	0.631	0.638	0.645	90
100	0.645	0.653	0.660	0.667	0.675	0.682	0.690	0.697	0.704	0.712	0.719	100
110	0.719	0.727	0.734	0.742	0.749	0.757	0.764	0.772	0.780	0.787	0.795	110
120	0.795	0.802	0.810	0.818	0.825	0.833	0.841	0.848	0.856	0.864	0.872	120
130	0.872	0.879	0.887	0.895	0.903	0.910	0.918	0.926	0.934	0.942	0.950	130
140	0.950	0.957	0.965	0.973	0.981	0.989	0.997	1.005	1.013	1.021	1.029	140
150	1.029	1.037	1.045	1.053	1.061	1.069	1.077	1.085	1.093	1.101	1.109	150
160	1.109	1.117	1.125	1.133	1.141	1.149	1.158	1.166	1.174	1.182	1.190	160
170	1.190	1.198	1.207	1.215	1.223	1.231	1.240	1.248	1.256	1.264	1.273	170
180	1.273	1.281	1.289	1.297	1.306	1.314	1.322	1.331	1.339	1.347	1.356	180
190	1.356	1.364	1.373	1.381	1.389	1.398	1.406	1.415	1.423	1.432	1.440	190
200	1.440	1.448	1.457	1.465	1.474	1.482	1.491	1.499	1.508	1.516	1.525	200
210	1.525	1.534	1.542	1.551	1.559	1.568	1.576	1.585	1.594	1.602	1.611	210
220	1.611	1.620	1.628	1.637	1.645	1.654	1.663	1.671	1.680	1.689	1.698	220
230	1.698	1.706	1.715	1.724	1.732	1.741	1.750	1.759	1.767	1.776	1.785	230
240	1.785	1.794	1.802	1.811	1.820	1.829	1.838	1.846	1.855	1.864	1.873	240
250	1.873	1.882	1.891	1.899	1.908	1.917	1.926	1.935	1.944	1.953	1.962	250
260	1.962	1.971	1.979	1.988	1.997	2.006	2.015	2.024	2.033	2.042	2.051	260
270	2.051	2.060	2.069	2.078	2.087	2.096	2.105	2.114	2.123	2.132	2.141	270
280	2.141	2.150	2.159	2.168	2.177	2.186	2.195	2.204	2.213	2.222	2.232	280
290	2.232	2.241	2.250	2.259	2.268	2.277	2.286	2.295	2.304	2.314	2.323	290
300	2.323	2.332	2.341	2.350	2.359	2.368	2.378	2.387	2.396	2.405	2.414	300
310	2.414	2.424	2.433	2.442	2.451	2.460	2.470	2.479	2.488	2.497	2.506	310
320	2.506	2.516	2.525	2.534	2.543	2.553	2.562	2.571	2.581	2.590	2.599	320
330	2.599	2.608	2.618	2.627	2.636	2.646	2.655	2.664	2.674	2.683	2.692	330
340	2.692	2.702	2.711	2.720	2.730	2.739	2.748	2.758	2.767	2.776	2.786	340
350	2.786	2.795	2.805	2.814	2.823	2.833	2.842	2.852	2.861	2.870	2.880	350
360	2.880	2.889	2.899	2.908	2.917	2.927	2.936	2.946	2.955	2.965	2.974	360
370	2.974	2.984	2.993	3.003	3.012	3.022	3.031	3.041	3.050	3.059	3.069	370
380	3.069	3.078	3.088	3.097	3.107	3.117	3.126	3.136	3.145	3.155	3.164	380
390	3.164	3.174	3.183	3.193	3.202	3.212	3.221	3.231	3.241	3.250	3.260	390
400	3.260	3.269	3.279	3.288	3.298	3.308	3.317	3.327	3.336	3.346	3.356	400
410	3.356	3.365	3.375	3.384	3.394	3.404	3.413	3.423	3.433	3.442	3.452	410
420	3.452	3.462	3.471	3.481	3.491	3.500	3.510	3.520	3.529	3.539	3.549	420
430	3.549	3.558	3.568	3.578	3.587	3.597	3.607	3.616	3.626	3.636	3.645	430
440	3.645	3.655	3.665	3.675	3.684	3.694	3.704	3.714	3.723	3.733	3.743	440
450	3.743	3.752	3.762	3.772	3.782	3.791	3.801	3.811	3.821	3.831	3.840	450
460	3.840	3.850	3.860	3.870	3.879	3.889	3.899	3.909	3.919	3.928	3.938	460
470	3.938	3.948	3.958	3.968	3.977	3.987	3.997	4.007	4.017	4.027	4.036	470
480	4.036	4.046	4.056	4.066	4.076	4.086	4.095	4.105	4.115	4.125	4.135	480
490	4.135	4.145	4.155	4.164	4.174	4.184	4.194	4.204	4.214	4.224	4.234	490
500	4.234	4.243	4.253	4.263	4.273	4.283	4.293	4.303	4.313	4.323	4.333	500
510	4.333	4.343	4.352	4.362	4.372	4.382	4.392	4.402	4.412	4.422	4.432	510
520	4.432	4.442	4.452	4.462	4.472	4.482	4.492	4.502	4.512	4.522	4.532	520
530	4.532	4.542	4.552	4.562	4.572	4.582	4.592	4.602	4.612	4.622	4.632	530
540	4.632	4.642	4.652	4.662	4.672	4.682	4.692	4.702	4.712	4.722	4.732	540
550	4.732	4.742	4.752	4.762	4.772	4.782	4.792	4.802	4.812	4.822	4.832	550
560	4.832	4.842	4.852	4.862	4.873	4.883	4.893	4.903	4.913	4.923	4.933	560
570	4.933	4.943	4.953	4.963	4.973	4.984	4.994	5.004	5.014	5.024	5.034	570
580	5.034	5.044	5.054	5.065	5.075	5.085	5.095	5.105	5.115	5.125	5.136	580
590	5.136	5.146	5.156	5.166	5.176	5.186	5.197	5.207	5.217	5.227	5.237	590
600	5.237	5.247	5.258	5.268	5.278	5.288	5.298	5.309	5.319	5.329	5.339	600
610	5.339	5.350	5.360	5.370	5.380	5.391	5.401	5.411	5.421	5.431	5.442	610
620	5.442	5.452	5.462	5.473	5.483	5.493	5.503	5.514	5.524	5.534	5.544	620
630	5.544	5.555	5.565	5.575	5.586	5.596	5.606	5.617	5.627	5.637	5.648	630
640	5.648	5.658	5.668	5.679	5.689	5.700	5.710	5.720	5.731	5.741	5.751	640
650	5.751	5.762	5.772	5.782	5.793	5.803	5.814	5.824	5.834	5.845	5.855	650
660	5.855	5.866	5.876	5.887	5.897	5.907	5.918	5.928	5.939	5.949	5.960	660
670	5.960	5.970	5.980	5.991	6.001	6.012	6.022	6.033	6.043	6.054	6.064	670
680	6.064	6.075	6.085	6.096	6.106	6.117	6.127	6.138	6.148	6.159	6.169	680
690	6.169	6.180	6.190	6.201	6.211	6.222	6.232	6.243	6.253	6.264	6.274	690
700	6.274	6.285	6.295	6.306	6.316	6.327	6.338	6.348	6.359	6.369	6.380	700
710	6.380	6.390	6.401	6.412	6.422	6.433	6.443	6.454	6.465	6.475	6.486	710
720	6.486	6.496	6.507	6.518	6.528	6.539	6.549	6.560	6.571	6.581	6.592	720
730	6.592	6.603	6.613	6.624	6.635	6.645	6.656	6.667	6.677	6.688	6.699	730
740	6.699	6.709	6.720	6.731	6.741	6.752	6.763	6.773	6.784	6.795	6.805	740
750	6.805	6.816	6.827	6.838	6.848	6.859	6.870	6.880	6.891	6.902	6.913	750
760	6.913	6.923	6.934	6.945	6.956	6.966	6.977	6.988	6.999	7.009	7.020	760
770	7.020	7.031	7.042	7.053	7.063	7.074	7.085	7.096	7.107	7.117	7.128	770
780	7.128	7.139	7.150	7.161	7.171	7.182	7.193	7.204	7.215	7.225	7.236	780
790	7.236	7.247	7.258	7.269	7.280	7.291	7.301	7.312	7.323	7.334	7.345	790
800	7.345	7.356	7.367	7.377	7.388	7.399	7.410	7.421	7.432	7.443	7.454	800
810	7.454	7.465	7.476	7.486	7.497	7.508	7.519	7.530	7.541	7.552	7.563	810
820	7.563	7.574	7.585	7.596	7.607	7.618	7.629	7.640	7.651	7.661	7.672	820
830	7.672	7.683	7.694	7.705	7.716	7.727	7.737	7.749	7.760	7.771	7.782	830
840	7.782	7.793	7.804	7.815	7.826	7.837	7.848	7.859	7.870	7.881	7.892	840
850	7.892	7.904	7.915	7.926	7.937	7.948	7.959	7.970	7.981	7.992	8.003	850
860	8.003	8.014	8.025	8.036	8.047	8.058	8.069	8.081	8.092	8.103	8.114	860
870	8.114	8.125	8.136	8.147	8.158	8.169	8.180	8.192	8.203	8.214	8.225	870
880	8.225	8.236	8.247	8.258	8.270	8.281	8.292	8.303	8.314	8.325	8.336	880
890	8.336	8.348	8.359	8.370	8.381	8.392	8.404	8.415	8.426	8.437	8.448	890

TYPE
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PLATINUM vs. PLATINUM-10% RHODIUM

TYPE S

Temperature in Degrees C

Reference Junction at 0°C

DEG C	0	1	2	3	4	5	6	7	8	9	10	DEG C
THERMOELECTRIC VOLTAGE IN ABSOLUTE MILLIVOLTS												
900	8.448	8.460	8.471	8.482	8.493	8.504	8.514	8.527	8.538	8.549	8.560	900
910	8.560	8.572	8.583	8.594	8.605	8.617	8.628	8.639	8.650	8.662	8.673	910
920	8.673	8.684	8.695	8.707	8.718	8.729	8.741	8.752	8.763	8.774	8.786	920
930	8.786	8.797	8.808	8.820	8.831	8.842	8.854	8.865	8.876	8.888	8.899	930
940	8.899	8.910	8.922	8.933	8.944	8.956	8.967	8.978	8.990	9.001	9.012	940
950	9.012	9.024	9.035	9.047	9.058	9.069	9.081	9.092	9.103	9.115	9.126	950
960	9.126	9.138	9.149	9.160	9.172	9.183	9.195	9.206	9.217	9.229	9.240	960
970	9.240	9.252	9.263	9.275	9.286	9.298	9.309	9.320	9.332	9.343	9.355	970
980	9.355	9.366	9.378	9.389	9.401	9.412	9.424	9.435	9.447	9.458	9.470	980
990	9.470	9.481	9.493	9.504	9.516	9.527	9.539	9.550	9.562	9.573	9.585	990
1.000	9.585	9.596	9.608	9.619	9.631	9.642	9.654	9.665	9.677	9.689	9.700	1.000
1.010	9.700	9.712	9.723	9.735	9.746	9.758	9.770	9.781	9.793	9.804	9.816	1.010
1.020	9.816	9.828	9.839	9.851	9.862	9.874	9.886	9.897	9.909	9.920	9.932	1.020
1.030	9.932	9.944	9.955	9.967	9.979	9.990	10.002	10.013	10.025	10.037	10.048	1.030
1.040	10.048	10.060	10.072	10.083	10.095	10.107	10.118	10.130	10.142	10.154	10.165	1.040
1.050	10.165	10.177	10.189	10.200	10.212	10.224	10.235	10.247	10.259	10.271	10.282	1.050
1.060	10.282	10.294	10.306	10.318	10.329	10.341	10.353	10.364	10.376	10.388	10.400	1.060
1.070	10.400	10.411	10.423	10.435	10.447	10.459	10.470	10.482	10.494	10.506	10.517	1.070
1.080	10.517	10.529	10.541	10.553	10.565	10.576	10.588	10.600	10.612	10.624	10.635	1.080
1.090	10.635	10.647	10.659	10.671	10.683	10.694	10.706	10.718	10.730	10.742	10.754	1.090
1.100	10.754	10.765	10.777	10.789	10.801	10.813	10.825	10.836	10.848	10.860	10.872	1.100
1.110	10.872	10.884	10.896	10.908	10.919	10.931	10.943	10.955	10.967	10.979	10.991	1.110
1.120	10.991	11.003	11.014	11.026	11.038	11.050	11.062	11.074	11.086	11.098	11.110	1.120
1.130	11.110	11.121	11.133	11.145	11.157	11.169	11.181	11.193	11.205	11.217	11.229	1.130
1.140	11.229	11.241	11.252	11.264	11.276	11.288	11.300	11.312	11.324	11.336	11.348	1.140
1.150	11.348	11.360	11.372	11.384	11.396	11.408	11.420	11.432	11.444	11.455	11.467	1.150
1.160	11.467	11.479	11.491	11.503	11.515	11.527	11.539	11.551	11.563	11.575	11.587	1.160
1.170	11.587	11.599	11.611	11.623	11.635	11.647	11.659	11.671	11.683	11.695	11.707	1.170
1.180	11.707	11.719	11.731	11.743	11.755	11.767	11.779	11.791	11.803	11.815	11.827	1.180
1.190	11.827	11.839	11.851	11.863	11.875	11.887	11.899	11.911	11.923	11.935	11.947	1.190
1.200	11.947	11.959	11.971	11.983	11.995	12.007	12.019	12.031	12.043	12.055	12.067	1.200
1.210	12.067	12.079	12.091	12.103	12.114	12.126	12.140	12.152	12.164	12.176	12.188	1.210
1.220	12.188	12.200	12.212	12.224	12.236	12.248	12.260	12.272	12.284	12.296	12.308	1.220
1.230	12.308	12.320	12.332	12.345	12.357	12.369	12.381	12.393	12.405	12.417	12.429	1.230
1.240	12.429	12.441	12.453	12.465	12.477	12.489	12.501	12.514	12.526	12.538	12.550	1.240
1.250	12.550	12.562	12.574	12.586	12.598	12.610	12.622	12.634	12.647	12.659	12.671	1.250
1.260	12.671	12.683	12.695	12.707	12.719	12.731	12.743	12.755	12.767	12.780	12.792	1.260
1.270	12.792	12.804	12.816	12.828	12.840	12.852	12.864	12.876	12.888	12.901	12.913	1.270
1.280	12.913	12.925	12.937	12.949	12.961	12.973	12.985	12.997	13.010	13.022	13.034	1.280
1.290	13.034	13.046	13.058	13.070	13.082	13.094	13.107	13.119	13.131	13.143	13.155	1.290
1.300	13.155	13.167	13.179	13.191	13.203	13.216	13.228	13.240	13.252	13.264	13.276	1.300
1.310	13.276	13.288	13.300	13.312	13.324	13.337	13.349	13.361	13.373	13.385	13.397	1.310
1.320	13.397	13.410	13.422	13.434	13.446	13.458	13.470	13.482	13.495	13.507	13.519	1.320
1.330	13.519	13.531	13.543	13.555	13.567	13.579	13.592	13.604	13.616	13.628	13.640	1.330
1.340	13.640	13.652	13.664	13.677	13.689	13.701	13.713	13.725	13.737	13.749	13.761	1.340
1.350	13.761	13.774	13.786	13.798	13.810	13.822	13.834	13.846	13.859	13.871	13.883	1.350
1.360	13.883	13.895	13.907	13.919	13.931	13.943	13.956	13.968	13.980	13.992	14.004	1.360
1.370	14.004	14.016	14.028	14.040	14.053	14.065	14.077	14.089	14.101	14.113	14.125	1.370
1.380	14.125	14.138	14.150	14.162	14.174	14.186	14.198	14.210	14.222	14.235	14.247	1.380
1.390	14.247	14.259	14.271	14.283	14.295	14.307	14.319	14.332	14.344	14.356	14.368	1.390
1.400	14.368	14.380	14.392	14.404	14.416	14.429	14.441	14.453	14.465	14.477	14.489	1.400
1.410	14.489	14.501	14.513	14.524	14.536	14.550	14.562	14.574	14.586	14.598	14.610	1.410
1.420	14.610	14.622	14.634	14.647	14.659	14.671	14.683	14.695	14.707	14.719	14.731	1.420
1.430	14.731	14.744	14.756	14.768	14.780	14.792	14.804	14.816	14.828	14.840	14.852	1.430
1.440	14.852	14.865	14.877	14.889	14.901	14.913	14.925	14.937	14.949	14.961	14.973	1.440
1.450	14.973	14.985	14.998	15.010	15.022	15.034	15.046	15.058	15.070	15.082	15.094	1.450
1.460	15.094	15.106	15.118	15.130	15.143	15.155	15.167	15.179	15.191	15.203	15.215	1.460
1.470	15.215	15.227	15.239	15.251	15.263	15.275	15.287	15.299	15.311	15.324	15.336	1.470
1.480	15.336	15.348	15.360	15.372	15.384	15.396	15.408	15.420	15.432	15.444	15.456	1.480
1.490	15.456	15.468	15.480	15.492	15.504	15.516	15.528	15.540	15.552	15.564	15.576	1.490
1.500	15.576	15.589	15.601	15.613	15.625	15.637	15.649	15.661	15.673	15.685	15.697	1.500
1.510	15.697	15.709	15.721	15.733	15.745	15.757	15.769	15.781	15.793	15.805	15.817	1.510
1.520	15.817	15.829	15.841	15.853	15.865	15.877	15.889	15.901	15.913	15.925	15.937	1.520
1.530	15.937	15.949	15.961	15.973	15.985	15.997	16.009	16.021	16.033	16.045	16.057	1.530
1.540	16.057	16.069	16.080	16.092	16.104	16.116	16.128	16.140	16.152	16.164	16.176	1.540
1.550	16.176	16.188	16.200	16.212	16.224	16.236	16.248	16.260	16.272	16.284	16.296	1.550
1.560	16.296	16.308	16.319	16.331	16.343	16.355	16.367	16.379	16.391	16.403	16.415	1.560
1.570	16.415	16.427	16.439	16.451	16.462	16.474	16.486	16.498	16.510	16.522	16.534	1.570
1.580	16.534	16.546	16.558	16.569	16.581	16.593	16.605	16.617	16.629	16.641	16.653	1.580
1.590	16.653	16.664	16.676	16.688	16.700	16.712	16.724	16.736	16.747	16.759	16.771	1.590
1.600	16.771	16.783	16.795	16.807	16.819	16.830	16.842	16.854	16.866	16.878	16.890	1.600
1.610	16.890	16.901	16.913	16.925	16.937	16.949	16.960	16.972	16.984	16.996	17.008	1.610
1.620	17.008	17.019	17.031	17.043	17.055	17.067	17.078	17.090	17.102	17.114	17.125	1.620
1.630	17.125	17.137	17.149	17.161	17.173	17.184	17.196	17.208	17.220	17.231	17.243	1.630
1.640	17.243	17.255	17.267	17.279	17.290	17.302	17.313	17.325	17.337	17.349	17.360	1.640
1.650	17.360	17.372	17.384	17.396	17.407	17.419	17.431	17.442	17.454	17.466	17.477	1.650
1.660	17.477	17.489	17.501	17.512	17.524	17.536	17.548	17.559	17.571	17.583	17.594	1.660
1.670	17.594	17.606	17.617	17.629	17.641	17.652	17.664	17.676	17.687	17.699	17.711	1.670
1.680	17.711	17.722	17.734	17.745	17.757	17.769	17.780	17.792	17.803	17.815	17.826	1.680
1.690	17.826	17.838	17.850									

RUN NO. 4

DATE: 1/25/77

Type "E" 1200°K, Helium Thermocouple, 23°C Reference

Pressure = .5 atm

$\Delta W = 2.00$ mg

Disk Sample

Comment: Good data but note weight gain in Helium!

<u>Time (sec)</u>	<u>Output (mv)</u>
0	0
15	27.5
30	46.5
45	57.5
60	62.0
75	64.5
90	65.5
105	67.0
120	68.5
150	70.0
180	70.0
192	70.0
195	66.5

RUN NO. 5

DATE: 1/26/77

Type "E" 1200⁰K, Helium Thermocouple, 23⁰C Reference

Pressure = .5 atm

$\Delta W = 1.44$ mg

Disk Sample

Comment: Good data with repeat of weight gain in Helium!

<u>Time (sec)</u>	<u>Output (mv)</u>
0	0
6	31
15	44
30	56.5
45	63
60	65
75	66
90	67
105	68
120	69
135	69.5
150	70.5
165	71
180	71.5
192	71.5
195	69
210	54

RUN NO. 6

DATE: 1/26/77

Type "E" 1200⁰K, Argon Thermocouple, 23⁰C Reference

Pressure = .5 atm

ΔW = 2.0 mg

Disk Sample

Comment: Weight gain in Argon!

<u>Time (sec)</u>	<u>Output (mv)</u>
0	0
15	40
30	61
45	69.5
60	71
62	0

RUN NO. 7

DATE: 1/26/77

Type "E" 1200⁰K Thermocouple, 23⁰C Reference

Pressure = .5 atm

$\Delta W = 7.15$ mg

Disk Sample

Comment: Good data, no He/Ar purge

<u>Time (sec)</u>	<u>Output (mv)</u>
0	0
6	32
15	52
30	67.5
45	70
60	70
90	70
120	70
150	70
180	70
210	70
240	70
270	70
300	69.5
315	58

RUN NO. 8

DATE: 1/26/77

Type "E" 1200⁰K, O₂ Thermocouple, 23⁰C Reference

Pressure = .5 atm

$\Delta W = 1.62$

Disk Sample

Comment: Looks okay - short run time however

<u>Time (sec)</u>	<u>Output (mv)</u>
0	0
6	29
15	49
30	67
33	68
39	68.5
45	70
60	70
90	70
93	70
105	57

RUN NO. 9

DATE: 1/26/77

Type "S" 1000⁰K, O₂ Thermocouple, 23⁰C Reference

Pressure = .5 atm

$\Delta W = 1.05$

Rectangular sample

Comment: Looks good - longer running time

<u>Time (sec)</u>	<u>Output (mv)</u>
0	0
6	1.4
15	2.9
30	5.0
45	6.1
60	6.55
75	6.65
90	6.65
105	6.6
120	6.55
135	6.55
150	6.5
180	6.5
210	6.45
240	6.45
270	6.4
300	6.4
330	6.4
360	6.4
390	6.4
420	6.4
450	6.4
480	6.4
510	6.4
540	6.4
570	6.4
585	6.4
594	6.4
600	5.4

RUN NO. 10

DATE: 1/26/77

Type "S" 1200° K, O₂ Thermocouple, 23° C Reference

Pressure = .5 atm

$\Delta W = 5.35$ mg

Rectangular Sample

Comment: Arco-over at 75 seconds with cool-down and subsequent re-heat

<u>Time (sec)</u>	<u>Output (mv)</u>
0	0
15	2.8
30	5.1
45	6.3
48	6.5
60	7.5
75	8.0
90	5.2
105	3.9
120	3.05
150	2.1
165	1.8
180	4.7
195	7.2
210	8.1
216	8.3
225	8.7
240	8.75
270	8.75
285	8.75
300	8.7
330	8.7
360	8.6
390	8.5
420	8.4
450	8.3
465	8.25
480	5.4

RUN NO. 11

DATE: 1/27/77

Type "S" 1500⁰K, O₂ Thermocouple, 23⁰C Reference

Pressure = .5 atm

$\Delta W = 22.7$

Rectangular Sample

Comment: Long transient period to reach 1500⁰K - data somewhat questionable!

<u>Time (sec)</u>	<u>Output (mv)</u>
0	0
10	2.8
15	4.5
20	6.1
30	8.1
35	8.6
40	9.1
41	9.2
45	8.4
50	9.4
60	10.6
70	10.8
75	10.5
80	10.8
90	12.2
95	12.0
100	12.3
105	12.4
110	12.4
115	12.3
120	12.2
130	12.2
140	12.2
150	12.2
151	12.2
155	9.3

RUN NO. 12

DATE: 1/27/77

Type "S" 1500⁰K, H₂O, 23⁰C Reference

Pressure = .5 atm

ΔW = 35 mg

Rectangular Sample

Comment: Some oxide coating lost, weight gain should be larger

<u>Time, (sec)</u>	<u>Output (mv)</u>
0	0
.5	.2
5	.2
10	.6
15	2.0
20	4.3
25	6.8
30	8.4
32	8.8
35	10.1
40	11.3
45	11.4
50	11.5
55	11.6
60	11.5
70	11.5
80	11.4
83	11.4
85	9.4

RUN NO. 15

DATE: 1/28/77

Type "S" 1200⁰K, H₂O Thermocouple, 23⁰C Reference

Pressure = .5 atm

ΔW = 5.37 mg

Rectangular Sample

Comment: Good data

<u>Time, (sec)</u>	<u>Output (mv)</u>
0	0
5	1.25
10	3.7
20	7.8
25	8.65
30	8.95
35	9.0
40	9.05
45	9.0
50	8.8
55	8.7
60	8.65
70	8.6
80	8.5
90	8.45
100	8.4
110	8.35
120	8.3
130	8.15
135	7.9
140	7.7
143	7.55
150	7.7
160	7.5
165	7.3
170	7.4
180	7.35

RUN NO. 15 Continued

<u>Time (sec)</u>	<u>Output (mv)</u>
185	7.4
190	7.5
200	7.8
210	8.1
220	8.5
230	8.8
235	8.7
240	8.65
250	8.7
260	8.7
270	8.7
280	8.7
290	8.7
300	8.7
310	8.7
320	8.6
330	8.6
340	8.55
350	8.5
360	8.5
370	8.45
380	8.4
390	8.4
400	8.35
410	8.3
415	8.3
420	6.6

RUN NO. 16

DATE: 2/1/77

Type "E" 1200⁰K, Air Thermocouple, 23⁰C Reference

Pressure = .5 atm

$\Delta W = 4.2$ mg

Rectangular Sample

Comment: Strip chart not available

<u>Time (sec)</u>	<u>Output (mv)</u>
0	0
5	1.05
10	2.0
20	3.9
30	5.4
40	6.4
50	7.1
55	7.55
60	8.05
70	8.6
80	8.85
90	8.95
95	8.95
100	8.9
105	8.85
110	8.8
120	8.8
130	8.8
140	8.75
150	8.7
160	8.7
170	8.65
180	8.6
190	8.6
200	8.6
210	8.55

RUN NO. 16 Continued

<u>Time (sec)</u>	<u>Output (mv)</u>
220	8.5
230	8.45
240	8.4
250	8.4
260	8.4
265	8.3
270	8.25
280	8.2
290	8.15
295	8.45
300	8.75
304	8.9
310	7.05

RUN NO. 17

DATE: 2/1/77

Type "E" 1200⁰K, Air Thermocouple, 23⁰C Reference

Pressure = .5 atm

ΔW = 6.2 atm

Rectangular Sample

Comment: Strip chart not available

<u>Time (sec)</u>	<u>Output (mv)</u>
0	0
10	2.54
20	5.25
30	7.00
40	7.85
50	8.15
59	8.35
60	8.10
65	7.00
70	6.25
71.5	6.10
80	6.80
85	7.20
90	7.90
95	8.55
100	8.75
105	8.80
110	8.90
120	9.0
130	9.05
140	9.05
150	9.00
160	8.90
165	8.85
170	8.75
180	8.70
185	8.65

RUN NO. 17 Continued

<u>Time (sec)</u>	<u>Output (mv)</u>
189	8.65
190	8.55
195	8.4
200	8.2
205	8.4
210	8.6
215	8.7
220	8.85
221	8.95
225	9.25
228	9.5
230	9.25
235	8.6
240	8.45
245	8.6
250	8.7
260	8.8
270	8.8
280	8.8
290	8.75
300	8.75
310	8.7
320	8.65
327	8.65
330	7.5

RUN NO. 18

DATE: 2/1/77

Type "S" 1500⁰K, O₂ + H₂O Thermocouple, 23⁰C Reference

Pressure = .5 atm

ΔW = 15 mg

Rectangular Sample

Comment: Some oxide flakes lost

<u>Time (sec)</u>	<u>Output (mv)</u>
0	0
2	.4
4	.8
10	3.0
15	4.9
20	6.6
25	8.1
30	9.0
35	10.0
40	10.6
44	10.8
50	11.5
60	11.9
70	12.0
80	12.0
90	12.0
95	11.9
102	11.9
105	8.8

SERIES 2
OXIDATION TESTS
MAY 1977

TITANIUM OXIDATION RUN SUMMARY: SERIES 2, MAY 1977

RUN NO.	NOMINAL TEMP (°K)	NOMINAL TIME (SEC)	PRESSURE (atm)	GAS COMPOSITION	WEIGHT GAIN (mg)	COMMENTS
2	1500	100	0.5	O ₂	16.15	No scale catcher in setup
3	1500	100	0.5	O ₂	19.74	No scale catcher in setup
4	1600	100	0.5	O ₂	73.75	
7	1650	50	0.5	O ₂	101.76	
8	1500	100	0.5	H ₂ O(v)	46.57	Baked out weight less 1.7 mg
9	1500	100	0.5	O ₂	22.34	
10	1450	100	0.5	H ₂ O(v)	35.22	Temp lower than 1500°K
11	1500	120	0.5	O ₂ H ₂ O(v)	18.82	Mix of gases uncertain, significant pressure change
12	1500	100	0.5	O ₂ H ₂ O(v)	19.66	Mix of gases uncertain, significant pressure change
15	1500	50	0.5	O ₂	11.97	
17	1650	60	0.5	O ₂	70.39	Temperature slightly low
18	1650	60	0.5	H ₂ O(v)	50.90	Temperature too low
19	1650	60	0.5	H ₂ O	63.20	Temperature too low
20	1200	300	0.5	H ₂ O(v)	8.56	
21	1200	300	0.5	H ₂ O(v)	8.10	
22	1500	35	1.0	O ₂	-	Specimen ignited
24	1400	50	1.0	O ₂	15.80	
25	1400	50	1.0	H ₂ O(v)	50.63	

NOTE: All specimens 1 cm x 2 cm x 0.2 cm, Mass = 1.8 gms. Thermocouples Type S.
Reference Temperature, 18° C. Chart speed 0.1 in/sec.

RUN NO. 1

DATE: 5/10/77

Type "S"

Comment: Shakedown and calibration run

<u>Time (sec)</u>	<u>Output (mv)</u>
0	0
10	4.0
20	6.9
30	10.2
40	11.1
50	12.1
60	12.4
65	12.5
70	12.5
80	12.5
90	12.5
100	12.6
110	12.6
120	12.6
130	12.7
140	12.7
147	12.7
150	10.8

RUN No. 2

DATE: 5/10/77

Type "S" 1500⁰ K, O₂ Thermocouple, 18⁰ C Reference

Pressure = .5 atm

$\Delta W = 16.15$ mg

Comment: Good test data

<u>Time (sec)</u>	<u>Output (mv)</u>
0	0
10	5.6
15	8.1
20	10.0
25	12.1
28	12.4
30	12.3
35	12.1
40	12.05
50	12.0
60	11.9
70	11.9
75	12.0
80	12.0
90	12.0
95	12.1
100	12.1
110	12.1
120	12.0
127	12.0
130	9.8

RUN NO. 3

DATE: 5/10/77

Type "S" 1500⁰ K, O₂ Thermocouple, 18⁰ C Reference

Pressure = .5 atm

$\Delta W = 19.74$ mg

Comment: Good test data

<u>Time (sec)</u>	<u>Output (mv)</u>
0	0
10	6.0
15	8.2
20	10.0
25	11.6
30	12.0
35	11.9
40	11.8
50	11.7
55	11.6
60	11.7
70	11.8
75	11.8
80	11.9
90	11.9
100	11.85
110	11.8
120	11.8
129	11.8
130	11.0

RUN NO. 4

DATE: 5/11/77

Type "S" 1700⁰K, O₂ Thermocouple, 18⁰C Reference

Pressure = .5 atm

ΔW = 73.75 mg

Comment: Temperature varies significantly between 1500 - 1700⁰K, questionable data

<u>Time (sec)</u>	<u>Output (mv)</u>
0	0
10	6.3
15	8.6
20	11.6
25	13.1
28	13.0
30	12.9
35	12.8
40	12.8
50	13.1
60	14.0
65	14.1
70	14.0
75	13.9
80	13.8
90	13.5
100	13.3
110	13.0
120	13.0
122	13.0
125	9.8

RUN NO. 5

DATE: 5/11/77

Type "S" 1500°K, H₂O(v) Thermocouple, 18°C Reference

Pressure = .15 atm at start, .5 atm at end of run

$\Delta W = 7.69$ mg

Comment: Widely varying pressure, questionable result

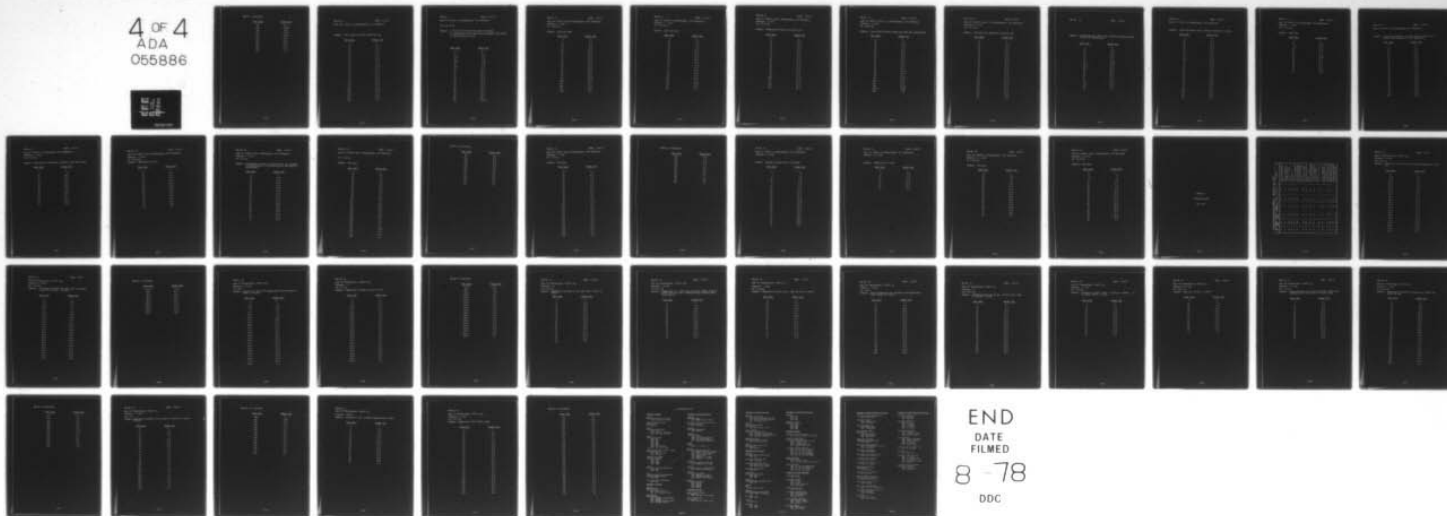
<u>Time (sec)</u>	<u>Output (mv)</u>
0	0
1	1.0
2	.8
6.5	.8
7	.2
18	.2
20	1.0
30	5.9
35	7.2
40	7.9
45	8.6
50	9.3
55	9.6
58	9.55
60	9.6
65	10.3
70	11.0
80	11.4
85	11.55
90	11.8
100	12.0
110	11.95
115	11.8
120	11.8
130	11.7
138	11.6

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SCIENCE APPLICATIONS INC EL SEGUNDO CALIF
TITANIUM RESPONSE TO SIMULATED NUCLEAR CLOUD PARTICLE ENVIRONME--ETC(U).
AUG 77 L E DUNBAR, R M CLEVER, G H BURGHART DNA001-76-C-0366
SAI-78-561-LA-VOL-2 DNA-4404F-2 NL

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4 OF 4
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END
DATE
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RUN NO. 5 Continued

<u>Time (sec)</u>	<u>Output (mv)</u>
140	11.7
145	11.85
150	12.0
157	12.15
160	12.15
165	12.0
170	12.0
180	11.9
190	11.8
195	11.7
200	8.2

RUN NO. 6

DATE: 5/13/77

Type "S", 1500 K, O₂ Thermocouple, 18 C Reference

Comment: Test invalid as oxide scale was lost

<u>Time (sec)</u>	<u>Output (mv)</u>
0	0
10	6.2
15	8.1
20	9.6
25	11.2
30	11.8
35	11.9
40	11.8
45	11.9
50	12.15
55	11.4
60	11.4
65	11.6
70	11.9
75	12.0
80	12.0
90	12.0
100	12.0
110	11.95
120	11.9
130	11.9
131	11.9
135	9.3

RUN NO. 7

DATE: 5/13/77

Type "S" 1700°K, O₂ Thermocouple, 18°C Reference

$\Delta W = 101.76 \text{ mg}$

Comment: 1) Arc-over and shut down after 50 seconds
2) Temperature varies significantly between 1600-1700°K
3) Data difficult to use

<u>Time (sec)</u>	<u>Output (mv)</u>
0	0
10	6.0
13.5	8.1
18	7.0
18.5	7.05
20	6.8
22.5	6.3
30	11.2
35	14.7
37	14.9
40	14.8
45	13.9
50	13.3
55	13.3
60	13.3
65	13.5
70	13.5
75	13.5
80	13.7
81	13.75

RUN No. 8

DATE: 5/13/77

Type "S" 1500⁰K, H₂O(v) Thermocouple, 18⁰C Reference

Pressure = .5 atm

$\Delta W = 46.57$ mg

Comment: Good test data

<u>Time (sec)</u>	<u>Output (mv)</u>
0	0
5	4.4
10	6.0
15	8.4
20	11.4
25	12.5
30	12.3
35	12.1
40	12.0
50	11.9
60	11.8
70	11.8
75	11.8
80	12.1
85	12.1
90	12.05
100	12.0
110	11.9
120	11.9
122	11.9
125	9.6

RUN NO. 9

DATE: 5/13/77

Type "S" 1500⁰K, O₂ Thermocouple, 18⁰C Reference

Pressure = .5 atm

$\Delta W = 22.34$ mg

Comment: Good test data

<u>Time (sec)</u>	<u>Output (mv)</u>
0	0
10	5.8
15	7.9
20	9.3
25	11.5
30	12.2
32	12.5
35	12.3
40	12.0
50	11.8
60	11.75
70	11.7
75	11.9
80	12.0
90	12.0
100	12.0
110	11.9
120	11.85
130	11.8
135	8.5

RUN NO. 10

DATE: 5/13/77

Type "S" 1500⁰K, H₂O(v) Thermocouple, 18⁰C Reference

Pressure = .5 atm

ΔW = 35.22 mg

Comment: Temperature slightly low during run

<u>Time (sec)</u>	<u>Output (mv)</u>
0	0
10	8.0
15	10.4
16	11.0
17	11.0
20	11.5
25	11.4
30	11.3
40	11.4
45	11.6
50	11.8
60	11.8
70	11.8
80	11.8
90	11.7
100	11.65
110	11.6
113	11.6
118	11.8
120	10.4

RUN NO. 11

DATE: 5/16/77

Type "S" 1500⁰K, H₂O(v) + O₂ Thermocouple, 18⁰C Reference

Pressure = .5 atm

ΔW = 18.81 mg

Comment: Significant pressure change may make data questionable

<u>Time (sec)</u>	<u>Output (mv)</u>
0	0
10	6.5
15	8.9
20	11.0
25	12.4
28	12.5
30	12.4
35	12.3
40	12.2
45	12.2
50	12.1
55	12.1
60	12.05
70	12.0
80	12.0
90	11.95
100	11.9
110	11.9
120	11.85
125.5	11.85
130	8.8

RUN NO. 12

DATE: 5/16/77

Type "S" 1500⁰K, H₂O(v) + O₂ Thermocouple, 18⁰C Reference

Pressure = .5 atm

ΔW = 19.66 mg

Comment: Good data but temperature slightly low

<u>Time (sec)</u>	<u>Output (mv)</u>
0	0
10	6.2
15	8.4
18	9.2
20	10.0
25	11.5
30	11.9
35	11.8
40	11.8
50	11.9
60	11.8
70	11.8
80	11.8
90	11.8
95	11.7
100	11.75
105	11.8
110	11.9
115	12.0
120	12.0
130	12.0
132	12.0
135	9.8

RUN NO. 13

DATE: 5/16/77

Comment: Calibration for 1700⁰K case overshoot caused specimen to melt off thermocouple

<u>Time (sec)</u>	<u>Output (mv)</u>
0	0
10	8.3
20	12.0
25	12.5
30	13.1
38	14.2
40	14.25
42.5	14.3
43.5	12.5
45	12.4
50	12.7
60	14.2
61	14.2
63	14.9
63.5	14.8
63.7	17.0
65	.7.0

RUN NO. 14

DATE: 5/16/77

Type "S" 1700⁰K, O₂ Thermocouple, 18⁰C Reference

Comment: Induction heater cut-out before temperature reached

<u>Time (sec)</u>	<u>Output (mv)</u>
0	0
10	8.3
12	9.1
15	11.0
20	12.8
25	13.2
29	13.2
30	12.4
32.5	10.1
35	11.4
40	12.7
45	13.15
48	13.2
50	13.4
55	13.6
60	13.6
65	13.7
70	13.8
80	13.8
90	13.7
100	13.6
105	13.5
107	13.5
110	10.5

RUN NO. 15

DATE: 5/16/77

Type "S" 1500⁰K, O₂ Thermocouple, 18⁰C Reference

Pressure = .5 atm

$\Delta W = 11.97$ mg

Comment: Good data

<u>Time (sec)</u>	<u>Output (mv)</u>
0	0
10	11.8
11.5	13.4
13	13.4
18	12.5
20	12.5
25	12.45
30	12.2
40	12.1
50	12.0
60	12.0
66	12.0
70	8.9

RUN NO. 16

DATE: 5/16/77

Type "S" 1700[°]K, O₂ Thermocouple, 18[°]C Reference

Comment: Pressure increased to 10 inch vacuum by end of run,
excess time required to reach temperature

<u>Time (sec)</u>	<u>Output (mv)</u>
0	0
10	7.3
15	10.2
20	12.6
25	13.5
30	13.6
35	13.5
40	13.6
45	13.7
50	13.9
55	13.8
60	13.8
65	14.0
70	14.0
76	14.0
80	14.1
85	14.2
90	14.2
99	14.2
100	13.4

RUN No. 17

DATE: 5/17/77

Type "S" 1700⁰K, O₂ Thermocouple, 18⁰C Reference

Pressure = .5 atm

$\Delta W = 70.39$ mg

Comment: Good data but temperature slightly lower than 1700⁰K

<u>Time (sec)</u>	<u>Output (mv)</u>
0	0
5	7.0
10	12.0
12	13.6
15	15.6
20	14.8
25	14.0
30	13.8
40	13.8
45	14.0
50	14.1
60	14.1
65	14.0
70	9.8

RUN NO. 18

DATE: 5/17/77

Type "S" 1700⁰K, H₂O(v) Thermocouple, 18⁰C Reference

Pressure = .5 atm

$\Delta W = 50.90$ mg

Comment: Temperature too low

<u>Time (sec)</u>	<u>Output (mv)</u>
0	0
10	11.4
15	13.3
20	13.8
22	13.8
25	14.0
30	14.0
40	13.9
50	13.8
55	13.7
60	13.6
65	13.6
70	13.6
75	13.6
80	9.4

RUN NO. 19

DATE: 5/17/77

Type "S" 1700⁰K, H₂O(v) Thermocouple, 18⁰C Reference

Pressure = .5 atm

ΔW = 63.2 mg

Comment: Condensation occurred on sample during run, pressure not maintained at 15 inch during run, data may be questionable

<u>Time (sec)</u>	<u>Output (mv)</u>
0	0
10	11.8
15	13.6
20	14.4
25	14.6
30	14.45
35	14.2
40	13.8
45	13.7
50	13.5
51	13.4
54	13.6
55	13.5
60	13.5
65	13.6
70	13.6
73	13.7
75	11.6

RUN No. 20

DATE: 5/17/77

Type "S" 1200⁰K, H₂O(v) Thermocouple, 18⁰C Reference

$\Delta W = 8.56$ mg

Comment: Good data

<u>Time (sec)</u>	<u>Output (mv)</u>
0	0
10	3.8
20	7.0
30	8.0
40	8.6
50	9.2
55	9.3
60	9.3
70	9.2
80	9.0
90	9.0
100	8.0
110	8.8
120	8.8
130	8.8
140	8.8
150	8.8
160	8.8
170	8.7
180	8.7
190	8.7
200	8.7
210	8.65
220	8.6
220	8.6
240	8.6

RUN NO. 20 Continued

<u>Time (sec)</u>	<u>Output (mv)</u>
250	8.6
260	8.6
270	8.6
280	8.6
290	8.6
300	8.6
310	8.6
320	8.6
330	8.6
340	8.6
345	8.6
350	7.2

RUN NO. 21

DATE: 5/17/77

Type "S" 1200⁰K, H₂O(v) Thermocouple, 18⁰C Reference

Pressure = .5 atm

$\Delta W = 8.1$ mg

Comment: Good data

<u>Time (sec)</u>	<u>Output (mv)</u>
0	0
10	3.5
20	6.2
30	7.5
35	7.8
40	8.1
50	9.2
52	9.5
55	9.5
60	9.3
70	9.0
80	8.8
90	8.75
100	8.7
110	8.6
120	8.6
130	8.6
140	8.6
150	8.6
160	8.6
170	8.6
180	8.5
190	8.5
200	8.5
210	8.5
230	8.4

RUN NO. 21 Continued

<u>Time (sec)</u>	<u>Output (mv)</u>
250	8.4
270	8.4
290	8.4
300	8.4
310	8.4
320	8.4
330	8.4
340	8.4
345	8.4
346	8.4
350	7.0

RUN NO. 22

DATE: 5/18/77

Type "S" 1500⁰K, O₂ Thermocouple, 18⁰C Reference

Pressure = 1.0 atm

Comment: Specimen ignited after 35 seconds

<u>Time (sec)</u>	<u>Output (mv)</u>
0	0
1	.6
7	.6
10	2.4
20	7.9
25	9.0
27	9.9
30	11.0
35	11.8
38	11.8
40	11.7
43	11.6
45	11.65
50	11.9
55	12.0
60	12.0
70	11.9
73	12.4
75	14.2
76	20.0
77	20.0
80	11.6

RUN NO. 23

DATE: 5/18/77

Type "S" 1400 K, O₂ Thermocouple, 18 C Reference

Pressure = 1.0 atm

Comment: Temperature too high

<u>Time (sec)</u>	<u>Output (mv)</u>
0	0
5	3.6
10	7.0
15	8.9
20	10.5
25	11.2
27	11.4
30	9.5

RUN NO. 24

DATE: 5/18/77

Type "S" 1400⁰K, O₂ Thermocouple, 18⁰C Reference

Pressure = 1.0 atm

$\Delta W = 15.8$ mg

Comment: Good data

<u>Time (sec)</u>	<u>Output (mv)</u>
0	0
10	5.8
15	7.6
18	8.3
20	9.0
25	10.7
28	11.0
30	11.0
35	10.8
40	10.6
45	10.6
50	10.7
55	10.8
60	10.8
70	10.8
77	10.8
80	8.9

RUN NO. 25

DATE: 5/18/77

Type "S" 1400⁰K, H₂O(v) Thermocouple, 18⁰C Reference

Pressure = 1.0 atm

$\Delta W = 50.63$ mg

Comment: Good data

<u>Time (sec)</u>	<u>Output (mv)</u>
0	0
0	.2
6.5	.2
10	2.4
15	6.7
20	7.8
25	8.9
30	9.9
40	10.9
45	11.0
50	11.1
55	11.1
60	10.9
65	10.8
70	10.8
80	10.7
90	10.6
91	10.6
95	8.2

SERIES 3

OXIDATION TESTS

JULY 1977

TITANIUM OXIDATION RUN SUMMARY: SERIES 3, JULY 1977

RUN NO.	NOMINAL TEMP (°K)	NOMINAL TIME (SEC)	PRESSURE (ATMOSPHERE)	GAS COMP.	WT. GAIN (mg)	COMMENTS
26	1500	60	0.5	H ₂ O	20.4	time more like 58-63 sec but steady temp. - good run
27	1450	85	1.0	H ₂ O	31.2	~ 53 sec at 1500°K but additional 35 sec init at ~ 1400°K! No good
28	1500	55	1.0	H ₂ O	40.0	~ 53-60 sec and steady good run.
29	1200	150	0.5	H ₂ O	6.8	Temp overshoot init ~ 40 sec
31	1600	70	0.5	H ₂ O	65.8	Temp low most of run, more like ~ 70 sec @ 1600°K
32	1600	80	0.5	H ₂ O	89.1	Temp low-more like 80 sec @ 1600°K slightly higher levels to run 31 however higher pressure may cause high AW
33	1600	60	0.5	O ₂	90.8	Temp erratic (low) time about 60 sec @ ~ 1600°K
34	1600	70	0.5	O ₂	102.4	Stable Temp not achieved, low temp ~ 70 sec @ 1600°K
35	1650	60	0.5	O ₂	120.7	1700°K maintained for only 10 sec -- ~60 sec total, most @ 1500°K+, no good
36	1600	50	0.5	O ₂	35.6	Overshoot to nearly 1700° ~ 30 sec @ ~ 1400°K, ~ 22 sec above 1500°K No good
37	1500	50	1.0	O ₂	15.9	Good run 50 sec @ ~1500°K
38	1500	50	1.0	O ₂	16.7	Slight overshoot for 1st 10 sec to ~1550°K and undershoot for last 40 sec to ~1450°K, good
39	1300	300	0.5	O ₂	10.8	Temp overshoot an ave. of ~1300°K for entire 300 sec
40	1300	300	0.5	O ₂	10.1	Temp overshoot an ave. of ~1300°K for entire 300 sec
41	1700	-	0.5	O ₂	-	Ignited at 5 sec, strange tc response above 1500°K
42	1250	300	0.5	H ₂ O	17.0	Temp 1200-1300°K, good

RUN NO. 26

DATE: 7/8/77

Type "S" Thermocouple, 1500°K, H₂O

Pressure = .5 atm

$\Delta W = 31.2$ mg

Comment: Time more like 58-63 sec but steady temperature, good run.

<u>Time (sec)</u>	<u>Output (mv)</u>
0	0
5.0	3.4
10.0	6.4
15.0	8.4
17.5	9.0
20.0	9.8
22.5	10.8
25.0	11.2
27.5	11.3
30.0	11.4
35.0	11.6
40.0	11.8
45.0	11.9
50.0	11.9
55.0	11.9
60.0	12.0
65.0	12.0
70.0	12.0
75.0	12.0
80.0	12.0
85.0	12.0
90.0	11.9
92.5	10.1

RUN NO. 27

DATE: 7/8/77

Type "S" Thermocouple, 1450⁰K, H₂O

Pressure = 1.0 atm

ΔW = 31.2 mg

Comment: ~53 seconds at 1500⁰K but additional 35 seconds
initial at ~1400⁰K. No good.

<u>Time (sec)</u>	<u>Output (mv)</u>
0	0
2.5	1.4
5.0	3.0
10.0	6.1
12.5	7.3
15.0	8.2
17.5	8.9
20.0	10.1
22.5	10.9
25.0	11.1
26.0	11.2
27.5	10.9
30.0	10.9
35.0	11.0
40.0	10.9
44.0	10.6
46.0	10.8
50.0	11.1
55.0	11.3
60.0	11.5
65.0	11.6
70.0	11.8
75.0	11.9
77.5	12.0

RUN NO. 27 continued

<u>Time (sec)</u>	<u>Output (mv)</u>
80.0	11.9
85.0	11.9
90.0	11.9
92.5	12.0
95.0	11.9
100.0	11.9
105.0	11.9
110.0	11.8
111.0	11.8
112.5	10.4

RUN No. 28

Type "S" Thermocouple, 1500⁰K, H₂O

Pressure = 1.0 atm

$\Delta W = 40.0$

Comment: ~53-60 sec at 1500⁰K but additional 35 sec initial at
~1400⁰K. No good

<u>Time (sec)</u>	<u>Output (mv)</u>
0	0
2.5	.3
5.0	2.8
7.5	5.1
8.5	5.7
10.0	7.8
12.5	9.2
15.0	10.4
17.0	11.2
18.0	11.2
20.0	11.4
22.5	11.7
25.0	12.0
30.0	12.1
35.0	12.0
40.0	12.0
45.0	12.0
50.0	11.9
55.0	11.9
60.0	11.9
65.0	11.9
70.0	11.8
75.0	11.8
77.0	11.8
80.0	9.2

RUN NO. 29

Type "S" Thermocouple, 1200°K, H₂O

Pressure = .5

$\Delta W = 6.8$ mg

Comment: Temperature overshoot initial ~40 sec

<u>Time (sec)</u>	<u>Output (mv)</u>
0	0
2.5	2.0
5.0	4.0
10.0	6.7
11.0	7.1
15.0	7.6
17.5	7.8
20.0	8.2
25.0	9.0
27.5	9.2
30.0	9.3
32.5	9.3
35.0	9.1
40.0	8.8
45.0	8.7
50.0	8.6
55.0	8.6
60.0	8.7
65.0	8.6
67.5	8.5
70.0	8.4
75.0	8.4
80.0	8.2
82.5	8.1
85.0	8.2

RUN NO. 29 continued

<u>Time (sec)</u>	<u>Output (mv)</u>
90.0	8.2
95.0	8.2
100.0	8.2
105.0	8.3
110.0	8.4
115.0	8.4
120.0	8.4
125.0	8.4
130.0	8.5
135.0	8.5
140.0	8.5
145.0	8.5
150.0	8.5
155.0	8.5
160.0	8.4
165.0	8.4
170.0	8.4
175.0	8.4
180.0	8.3
182.5	6.7

RUN NO. 31

DATE: 7/11/77

Type "S" Thermocouple, 1700⁰K, H₂O

Pressure = .5

ΔW = 65.8 mg

Comment: Temperature low most of run, more like ~70 sec at 1600⁰K.

<u>Time (sec)</u>	<u>Output (mv)</u>
0	0
5	6.6
10	10.3
15	12.5
20	12.9
25	13.3
30	13.5
35	13.8
40	13.8
50	13.8
60	13.6
65	13.4
70	13.5
80	14.0
85	14.2
87	14.0
90	9.3

RUN NO. 32

DATE: 7/11/77

Type "S" Thermocouple, 1700°K, H₂O

Pressure = .5 atm

ΔW = 89.1 mg

Comment: Temperature low ~ more like 80 sec at 1600°K, slightly higher levels to RUN 31 however higher pressure may cause high ΔW

<u>Time (sec)</u>	<u>Output (mv)</u>
0	0
10	7.4
15	11.4
20	13.0
25	13.2
30	13.3
35	13.7
40	14.0
50	13.7
55	13.8
60	13.9
70	14.0
73	14.1
75	13.5

RUN NO. 33

DATE: 7/11/77

Type "S" Thermocouple, 1700°K, O₂

Pressure = .5 atm

ΔW = 9.08 mg

Comment: Temperature erratic, low; time ~60 sec at ~1600°K

<u>Time (sec)</u>	<u>Output (mv)</u>
0	0
10	9.7
15	13.3
20	13.0
25	13.4
30	14.1
40	13.8
50	13.2
55	13.5
60	13.0
63	12.6
64	13.6
70	13.3
72	13.2
74	9.8

RUN NO. 34

DATE: 7/11/77

Type "S" Thermocouple, 1700⁰K, O₂

Pressure = .5 atm

$\Delta W = 102.4$

Comment: Stable temperature not achieved, low temperature,
time ~70 sec at ~1600⁰K.

<u>Time (sec)</u>	<u>Output (mv)</u>
0	0
10	7.8
15	10.8
20	13.0
25	13.2
30	13.4
40	14.0
45	13.9
47	13.8
50	13.9
53	14.1
60	13.9
65	13.8
70	13.7
75	13.5
78	13.4
80	12.7
90	12.4
98	12.0
100	10.0

RUN NO. 35

DATE: 7/12/77

Type "S" Thermocouple, 1600°K, O₂

Pressure = .5

ΔW = 120.7 mg

Comment: 1700° maintained only 10 sec, ~60 sec total, most
at 1500°K+, no good

<u>Time (sec)</u>	<u>Output (mv)</u>
0	0
10	5.3
15	6.9
20	9.7
25	11.4
27	11.4
30	12.0
35	13.8
40	13.8
42	13.8
45	12.2
50	12.0
60	12.1
70	12.3
75	12.3
80	12.3
85	12.2
89	12.2
90	11.6

RUN NO. 36

DATE: 7/12/77

Type "S" Thermocouple, 1500⁰K, O₂

Pressure = .5 atm

ΔW = 35.6 mg

Comment: Overshoot to nearly 1700⁰; ~30 sec at ~1400⁰K; 27
sec above 1500⁰K, no good

<u>Time (sec)</u>	<u>Output (mv)</u>
0	0
5	5.2
10	9.0
15	13.4
20	12.4
25	11.6
30	11.0
40	10.8
50	10.8
55	10.9
60	11.0
63	11.0
65	9.6

RUN NO. 37

DATE: 7/12/77

Type "S" Thermocouple, 1500⁰K, O₂

Pressure = 1.0 atm

$\Delta W = 15.9$ mg

Comment: Good run, 50 sec at $\sim 1500^0$ K

<u>Time (sec)</u>	<u>Output (mv)</u>
0	0
10	7.0
15	9.6
20	11.6
22	11.9
25	11.8
30	11.5
35	11.4
40	11.3
50	11.2
60	11.2
68	11.2
70	9.4

RUN NO. 38

DATE: 7/12/77

Type "S" Thermocouple, 1500⁰K, O₂

Pressure = 1.0 atm

ΔW = 16.7 mg

Comment: Slight overshoot for first 10 sec to ~1550⁰K and undershoot for last 40 sec to ~1450⁰K, good

<u>Time (sec)</u>	<u>Output (mv)</u>
0	0
5	5.2
10	8.0
15	11.0
20	12.0
25	11.2
30	10.9
35	10.7
40	10.7
45	10.8
50	10.9
55	11.0
60	11.0
68	11.0
70	9.4

RUN NO. 39

Type "S" Thermocouple, 1300°K, O₂

Pressure = .5 atm

ΔW = 10.8 mg

Comment: Temperature overshoot and average of ~1300°K for entire 300 sec

<u>Time (sec)</u>	<u>Output (mv)</u>
0	0
10	5.9
20	9.0
25	9.8
30	10.3
35	10.5
40	10.4
45	10.4
50	10.3
55	10.2
60	10.1
70	10.0
80	10.0
90	9.9
100	9.8
110	9.8
120	9.7
130	9.7
140	9.6
150	9.6
160	9.6
170	9.5
180	9.5
190	9.5
200	9.4

RUN NO. 39 continued

<u>Time (sec)</u>	<u>Output (mv)</u>
210	9.4
220	9.3
230	0.2
240	9.2
250	9.2
260	9.1
270	9.15
280	9.1
290	9.1
300	9.2
310	9.2
318	9.2
320	7.8

RUN NO. 40

DATE: 7/13/77

Type "S" Thermocouple, 1300°K, O₂

Pressure = .5 atm

$\Delta W = 10.1$

Comment: Temperature overshoot and average of ~1300°K for entire
300 sec

<u>Time (sec)</u>	<u>Output (mv)</u>
0	0
10	4.4
15	6.0
20	7.3
25	8.0
30	8.4
35	8.9
40	9.4
45	9.6
50	9.7
60	9.6
70	9.5
80	9.4
90	9.4
100	9.3
110	9.2
120	9.2
130	9.2
140	9.2
150	9.2
160	9.2
170	9.1
180	9.1
190	9.1

RUN NO. 40 continued

<u>Time (sec)</u>	<u>Output (mv)</u>
200	9.1
210	9.05
220	9.0
230	9.0
240	9.0
250	9.0
260	9.0
270	9.0
280	9.0
290	9.0
300	9.0
310	9.0
320	9.0
327	9.0
330	8.0

RUN NO. 41

Type "S" Thermocouple, 1700⁰K, O₂

Pressure = 1700 K

Comment: Ignited at 5 sec, strange response above 1500⁰K

<u>Time (sec)</u>	<u>Output (mv)</u>
0	0
5	2.7
10	5.8
15	8.3
20	11.0
22	11.7
25	12.4
30	12.2
35	12.2
40	12.9
45	14.8
47	15.3
48	19.8
49	19.8
50	14.2

RUN NO. 42

Type "S" Thermocouple, 1250⁰K, H₂O

Pressure = .5 atm

$\Delta W = 17.0$ mg

Comment: Temperature 1200⁰-1300⁰K, good

<u>Time (sec)</u>	<u>Output (mv)</u>
0	0
10	4.4
15	6.4
20	7.4
25	7.9
30	8.3
35	8.6
40	8.8
42	8.9
43	8.4
45	8.3
47	8.2
50	8.2
60	8.4
70	8.6
80	8.7
85	8.7
90	8.6
100	8.8
105	8.2
108	8.2
110	8.5
115	8.6
120	8.2
125	8.6

RUN NO. 42 continued

<u>Time (sec)</u>	<u>Output (mv)</u>
130	8.7
135	8.6
140	8.5
145	8.6
150	8.7
155	8.5
160	8.6
165	8.7
170	8.7
175	8.8
180	8.8
190	8.9
200	9.0
210	9.0
220	9.0
230	9.0
240	9.0
245	9.1
250	9.1
260	9.1
270	9.1
280	9.1
285	9.2
290	9.2
300	9.2
310	9.2
320	9.2
330	9.2
332	9.2
335	7.9

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